Construction Methods

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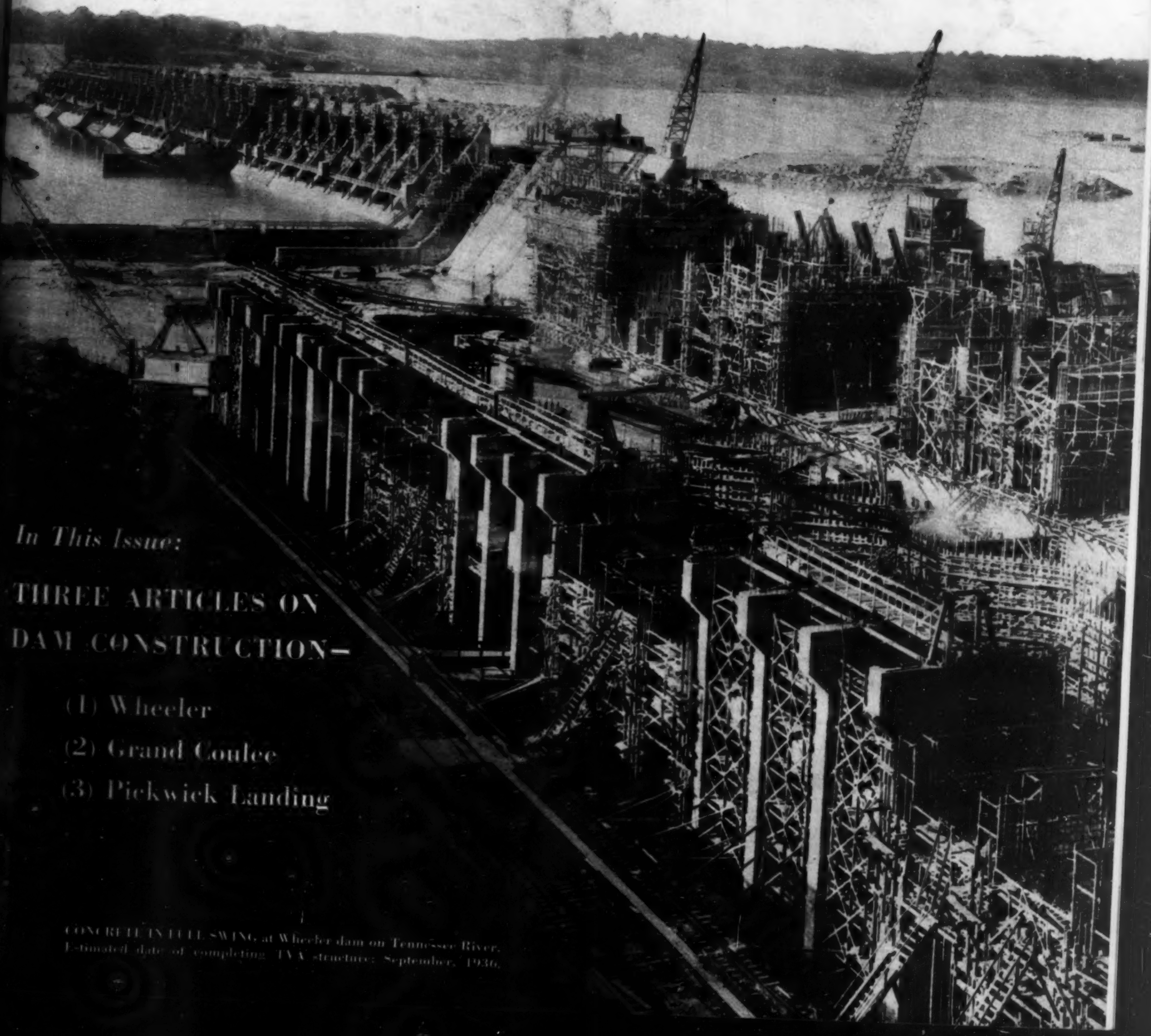

In This Issue:

THREE ARTICLES ON DAM CONSTRUCTION—

(1) Wheeler

(2) Grand Coulee

(3) Pickwick Landing

CONCRETE IN FULL SWING, at Wheeler dam on Tennessee River. Estimated date of completing TVA structure: September, 1936.


OLD NEPTUNE, lashing his waters into fury and breeding his billions of destructive borers, holds no terrors for walls of Steel Sheet Piling. For marine structures—wharves, jetties, sea-walls and the like—steel sheet piling provides the strength, the permanence and the economy of Steel in the most convenient form. Many years of practical experience with all types of construction and the development of an extremely efficient range of piling sections give us confidence in our ability to serve you.
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Construction Methods

McGraw-Hill Publishing Company, Inc.,
330 West 42nd St., New York

Robert K. Tomlin, Editor

SEPTEMBER, 1935

Willard Chevalier, Vice-President

Editorial Staff: Vincent B. Smith, N. A. Bowers (San Francisco)
Leonard H. Church (Cleveland), Nelle Fitzgerald

Flood of PWA Projects

● Municipal plans for public works are rising to a volume greater than PWA can possibly finance. More than 3,000 project applications have been filed with PWA for grants and loans totaling $750,000,000. State PWA directors anticipate that twice as many more will be submitted.

Disillusioned by their experience with the CWA program two years ago, many communities are demanding that their projects be handled by PWA rather than WPA and are willing to bear 55 per cent of the cost to support their preference, even on projects costing less than $25,000 that would ordinarily fall within WPA's jurisdiction.

"The policy of the whole administration," Administrator Ickes asserted last month, "is to favor PWA projects as that means a contribution by the communities for local improvements." This statement received apparent confirmation from WPA Administrator Hopkins, who said that WPA will not undertake projects for which the communities are able and ought to borrow the money.

Prospects for Highway Program

● Highway and street officials have a fund well in excess of a billion dollars at their command for utilization within the next 12 months, and if programs are properly and quickly presented the total for the year may exceed $1,500,000,000, it was disclosed in a recent summary made by the American Road Builders' Association of actual and potential allotments. The highway-street-grade crossing set-up now stands:

Federal-aid (to be matched by States)	$125,000,000
States (if they match Federal-aid)	125,000,000
Emergency Relief Funds for Highways, Secondary Roads and Streets	200,000,000
Emergency Relief Funds for Grade Crossing Elimination and Protection	200,000,000
Total allotted	650,000,000
Potential Emergency Relief Funds for Highways, Streets and Grade Crossings, not yet allotted	300,000,000
State Funds in Excess of Requirements to Match Federal-aid (estimated)	100,000,000
Grand total	$1,050,000,000

No estimate has been made of the amount that is expected to be made available by the Federal Government, through the Works Progress Administration, for the farm-to-market road program.

Deadlines Set For Work Projects

● All applications for a share of the $4,800,000,000 appropriated by Congress for emergency work relief must be in the hands of the Division of Applications and Information of the National Emergency Council by Sept. 12, according to a letter addressed to the heads of the various departments and agencies affected by the President. Other deadlines are set as follows: Approval by D.A.I., Sept. 17; action by the Secretary of the Treasury and the Comptroller-General, Sept. 24; requests for bids on contract operations or start of force-account work, Oct. 22; award of contracts, Dec. 15.

Talburt, in Scripps-Howard Newspapers

No Time to Look Around!

Such is the ambitious program scheduled in the latest drive to put men to work. Published without preliminary warning, it is bound to bring forth a flood of applications hitherto delayed for more or less justifiable reasons. Whether or not the schedule will be adhered to remains to be seen. It is self-evident that a complete program for such a large amount distributed over thousands of small projects cannot possibly be submitted before Sept. 12.

With this consideration in mind, it seems probable that after the deadline has been passed justification will be found for a great many applications, although the ruling will undoubtedly provide an excuse for rejecting distasteful projects.

Principles for Selection of Secondary Roads

● Eleven guiding principles for the selection and construction of secondary or feeder roads in rural areas to be improved with funds appropriated by the Emergency Relief Act were promulgated last month by the Secretary of Agriculture. The principles have been sent to the state highway departments and to the U. S. Bureau of Public Roads for their use in planning secondary road projects in the states. Among the factors recommended for initial consideration in the rural roads program are availability of employable skilled relief workers, possibilities of project creating economic and social values in areas served, present and potential volume of traffic, and connections with existing improved highway systems.

Not less than $50,000,000 of the $200,000,000 highway fund allotted from money provided by the Emergency Relief Act is to be applied to secondary roads, in addition to expenditures for secondary road construction to be undertaken directly by WPA forces, as commented upon elsewhere on this page.

Secondary Roads With WPA Funds

● Adoption of an extensive farm-to-market road program as one of the principal features of relief works planned by the Works Progress Administration makes it unlikely that the states will receive any further allotments for highway construction and grade-crossing elimination. The allotment of $500,000,000 to date is $300,000,000 short of the allocation made by Congress but President Roosevelt will probably stop at that figure. He has wide latitude to shift funds at will.

WPA is expected to spend as much in earth and the cheaper grades of bituminous road construction as the states have been allotted for their highway programs, of which a minimum of 25 per cent must be spent on secondary roads.

Perry Fellows, acting chief engineer of FERA, will have charge of the WPA road program. Administrators will be appointed in each state. State highway departments will be requested to cooperate in an advisory capacity only. The program will be mapped by counties on the basis of the number of men on relief rolls and the need for rural roads. It is estimated that the program will employ 600,000 men at a cost of $800 per man-year for labor and materials.

To Stabilize Equipment Industry

● With the avowed purpose of creating and maintaining stabilization in the construction equipment industry by outlawing unfair and destructive competitive methods there is being organized the Construction Equipment Association, sponsored by important groups representing the makers and the vendors of construction machinery. As planned, the organization is to be a federation of trade associations and groups of equipment manufacturers through which action may be taken to express the majority opinion of its members where it seems necessary or desirable for the industry to make its voice heard. Under present conditions, and particularly since the abolition of NRA code regulations, there are countless opportunities for the new organization to improve the relationships existing among manufacturers, distributors and purchasers of construction equipment. In developing the new organization, however, its main purpose as a trade association, rather than as a promotional agency in competition with existing groups in special fields organized for that purpose, should be kept clearly in mind.

Modern Methods— Modern Plant— Modern Management

THIS IS written while on a visit to a construction job with the contractor who is handling it. The job runs about $800,000; it was taken on a competitive bid; it involves a variety of operations of which earth-moving is a substantial part.

The contractor is an aggressive, progressive sample of his breed. He knows his business. He knows when to take a job and when to turn one down; he knows that no volume of work at a unit loss can add up to a profit. He cooperates closely with the several engineers and inspectors who supervise his work and they are glad to work helpfully with him.

His job is moving, every part of it is clicking along at speed; he stands to earn a reasonable profit. And if some of those who do so much wolfing about "contractors' profits" but knew the moderate return on his skill and toil that this competent workman considers a reasonable profit, they might revise their notions. Altogether the visit is instructive and stimulating to one who enjoys the feel of a well-run job.

ONE OF the most interesting sides of this particular contractor is his attitude toward plant. It takes but a glance at his job to see that each piece of equipment is well adapted to its work. One relatively new type of machine is the first of its kind to go on a job in these parts. The several pieces of plant all bear the names of well-advertised and respected makers. Much of it is new: during the last two years this contractor has put some $150,000 into new plant. He follows consistently the equipment advertisements: in the course of this visit he has commented with interest on certain installation and performance data, given in a *Construction Methods* advertisement, as compared with his own experience. He gets many ideas from his close reading of these advertisements which, he says, are as valuable to him as the reading pages.

He doesn't buy haphazardly; it would be illuminating to manufacturers to hear him discuss the whys and wherefores of his plant. He knows that he cannot afford the luxury of outworn and obsolete plant so he buys the best he knows and writes it off quickly out of the savings it earns for him. He regularly reinvests a substantial part of his earnings in new plant that will maintain his standard of efficiency. He wants only the most efficient life of his plant; he manages so that when that is over he can afford to replace it. Altogether his plant policy is exactly that which is followed by progressive leaders in other industries. It is a modern, twentieth-century policy, adapted to a mechanized construction industry rather than to the old horse-and-man-power practice of another age.

This case is cited not because it is unique; thousands of successful contractors the country over follow precisely the same policy. It is cited here only because this man is a *specific case,* not just an ideal in the mind of a writer. He is a practical, successful, flesh-and-blood contractor, carrying on real work and earning a profit on it.

To be sure, his success is not due to his plant policy alone: he has the other qualities and capacities that make for success in his exacting business. But there can be no doubt that his grasp of plant economics is a major factor in his ability to handle work effectively and profitably.

THE MERE possession and use of machinery does not distinguish the modern constructor from the contractor of an earlier day; the test is his understanding of how to select, use and *retire* each element of his plant with due regard for consistent performance and overall economy. Too often the crude operating methods of rough-and-ready days are carried over into the modern job; one symptom of this is a burden of worn-out, obsolete or ill-adapted plant that sooner or later breaks the back of its owner.

Modern methods, modern plant, ***modern management;*** all three of these are essential to success in modern construction.

Willard Chevalier

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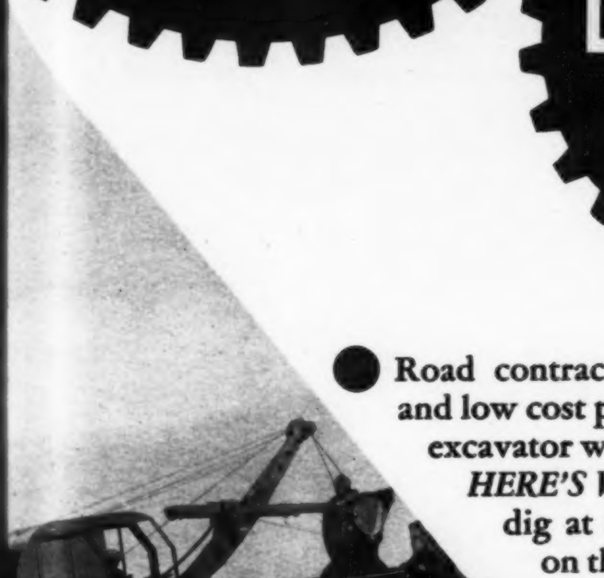

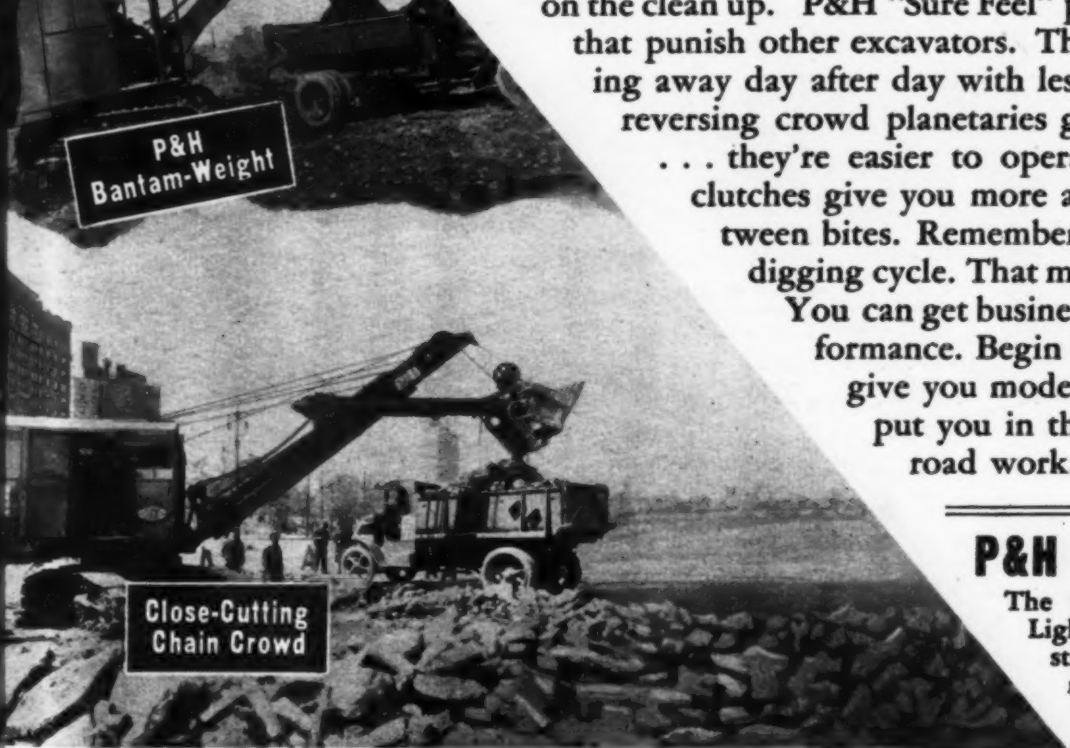

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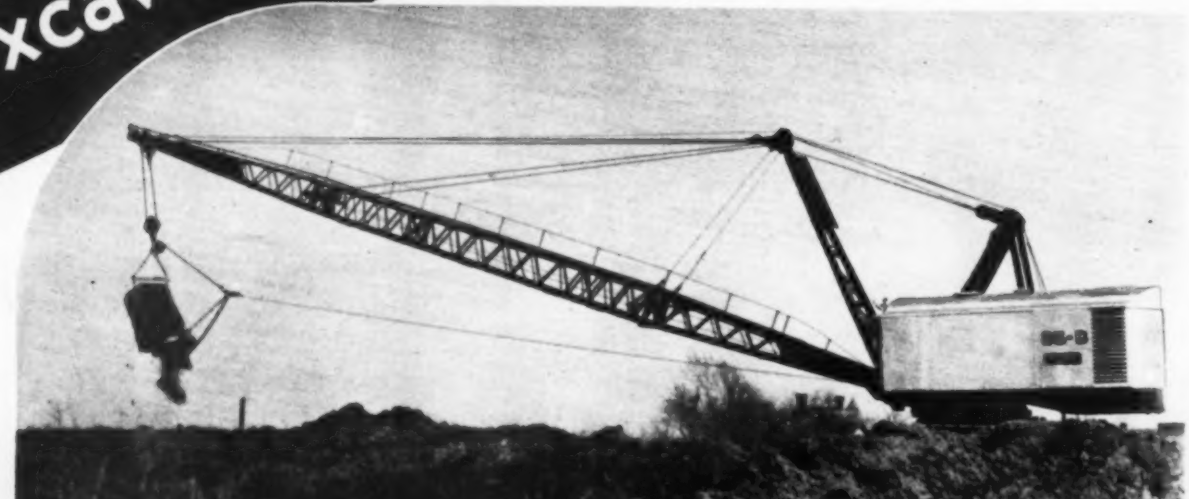

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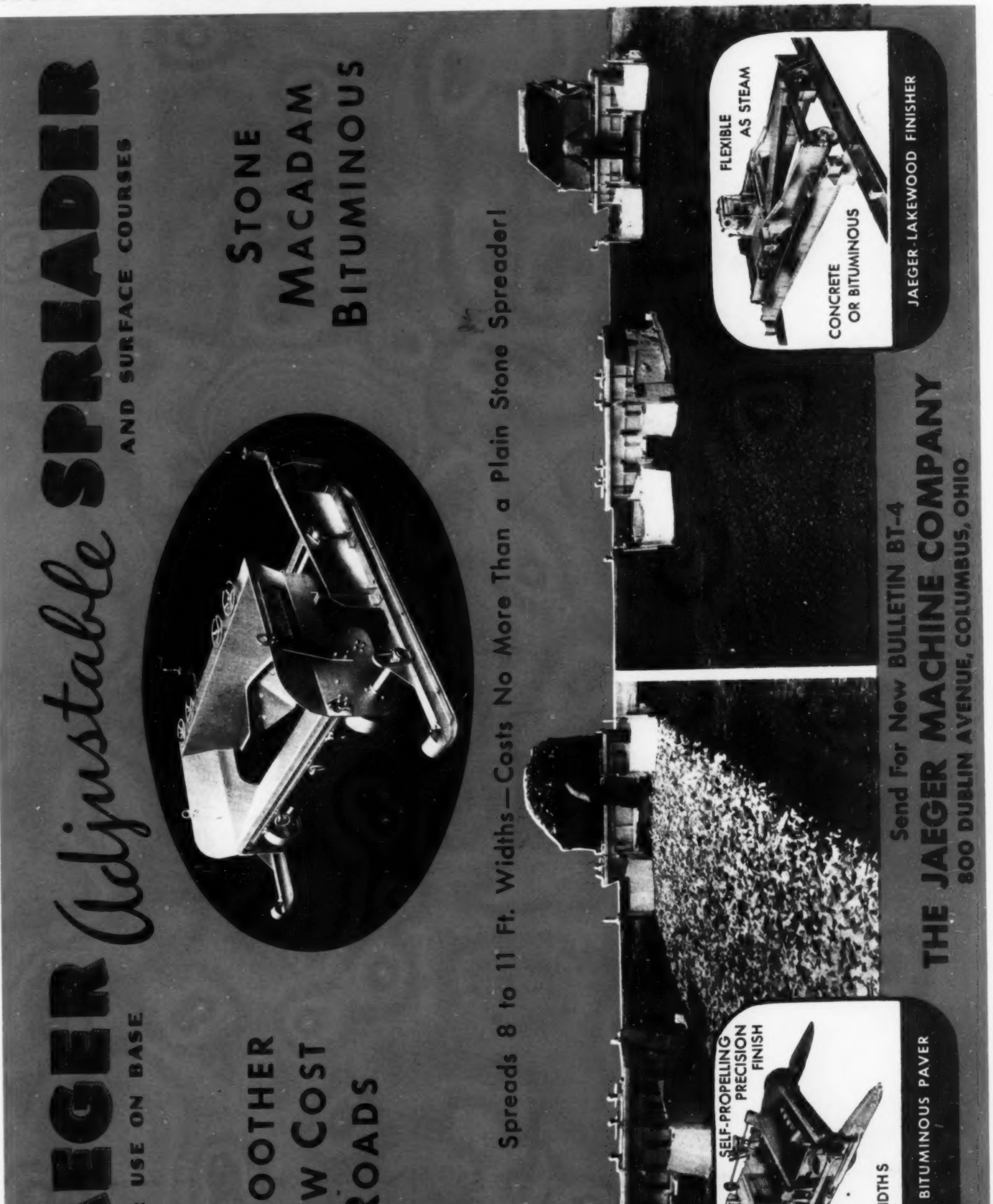

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Big holes, big powder—a big job any way you look at it. But the use of Cordeau-Bickford Detonating Fuse means:

Simplified Loading: No cap in the cartridge—Cordeau itself is the detonator.

Less Hazard: Cordeau is insensitive—it must be detonated in order to detonate!

More Work: Each cartridge, being detonated directly by the Cordeau, has the added force of a primer cartridge.

Thousands of well drill holes, Cordeau detonated, can "go" as one giant blast, yet be so planned that each row relieves the burden for succeeding rows. Better fragmentation means easier removal—easier crushing.

Send for the Cordeau Book. It illustrates and describes a technique in blasting that can be applied to Jackhammer and Wagon Drill holes too, for small shots as well as larger ones.

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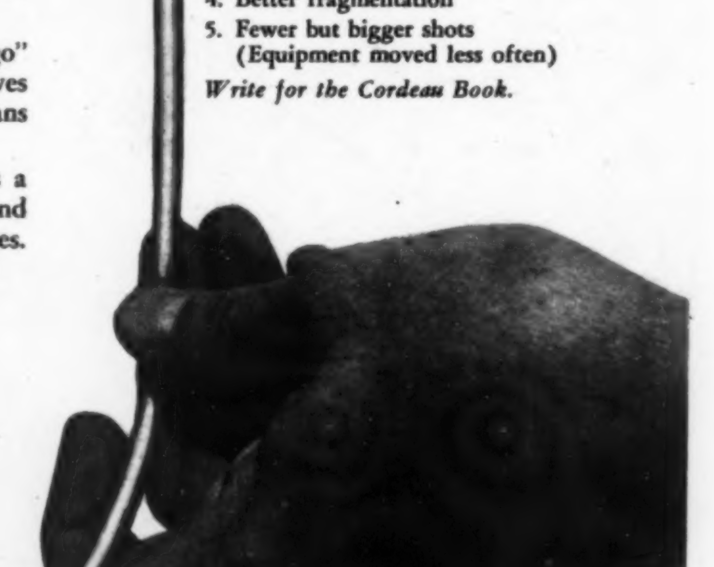
4. Better fragmentation
5. Fewer but bigger shots (Equipment moved less often)

Write for the Cordeau Book.



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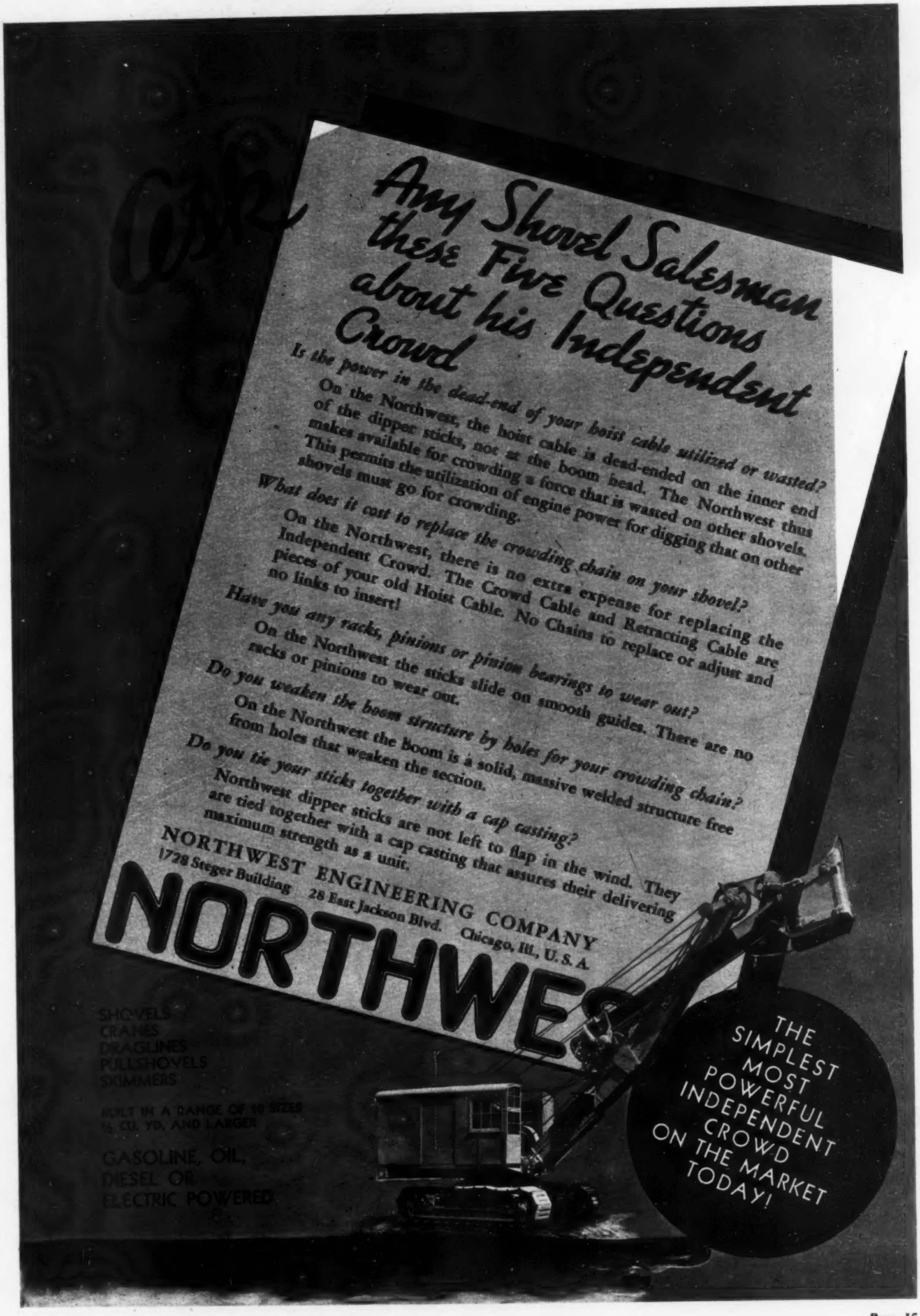
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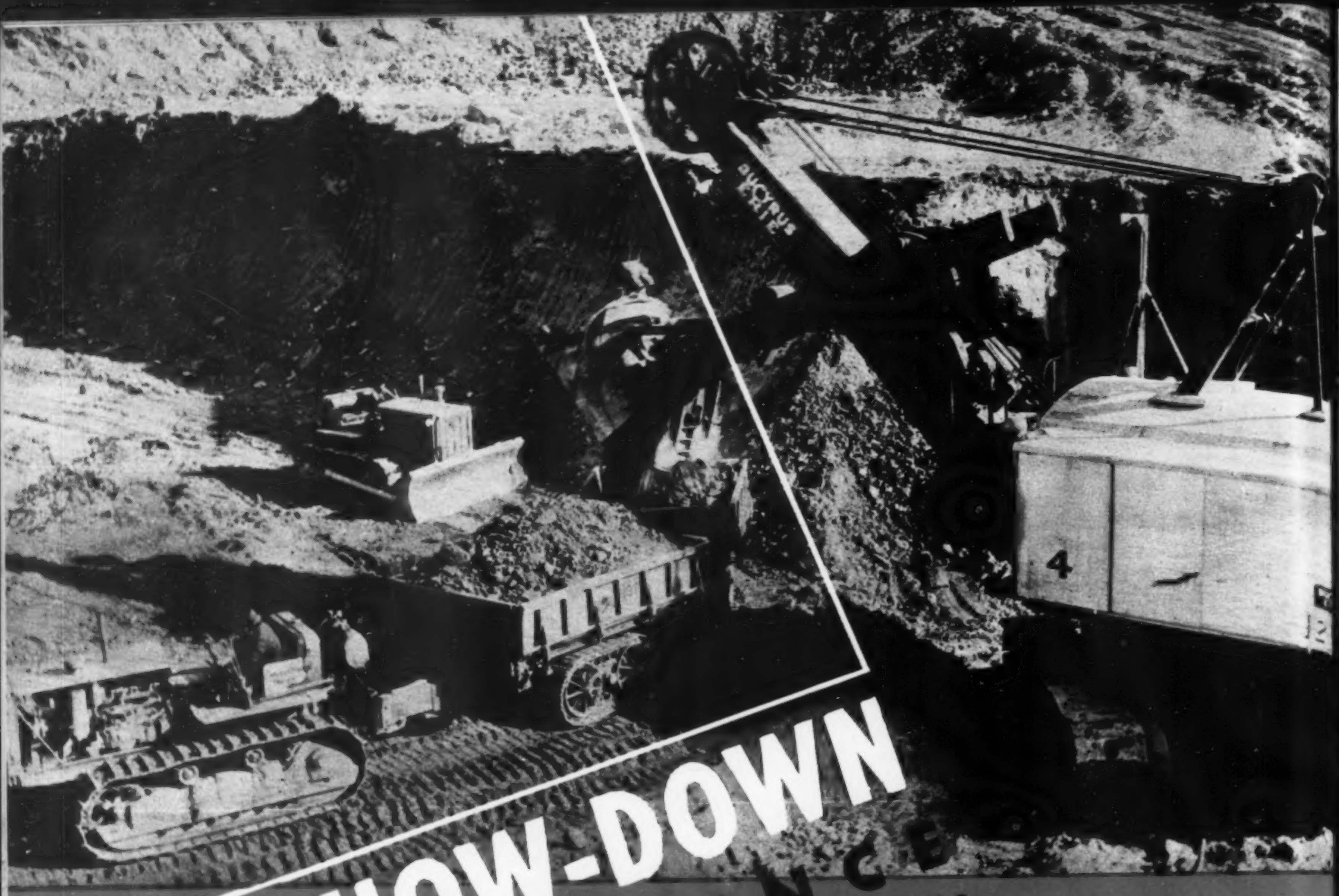

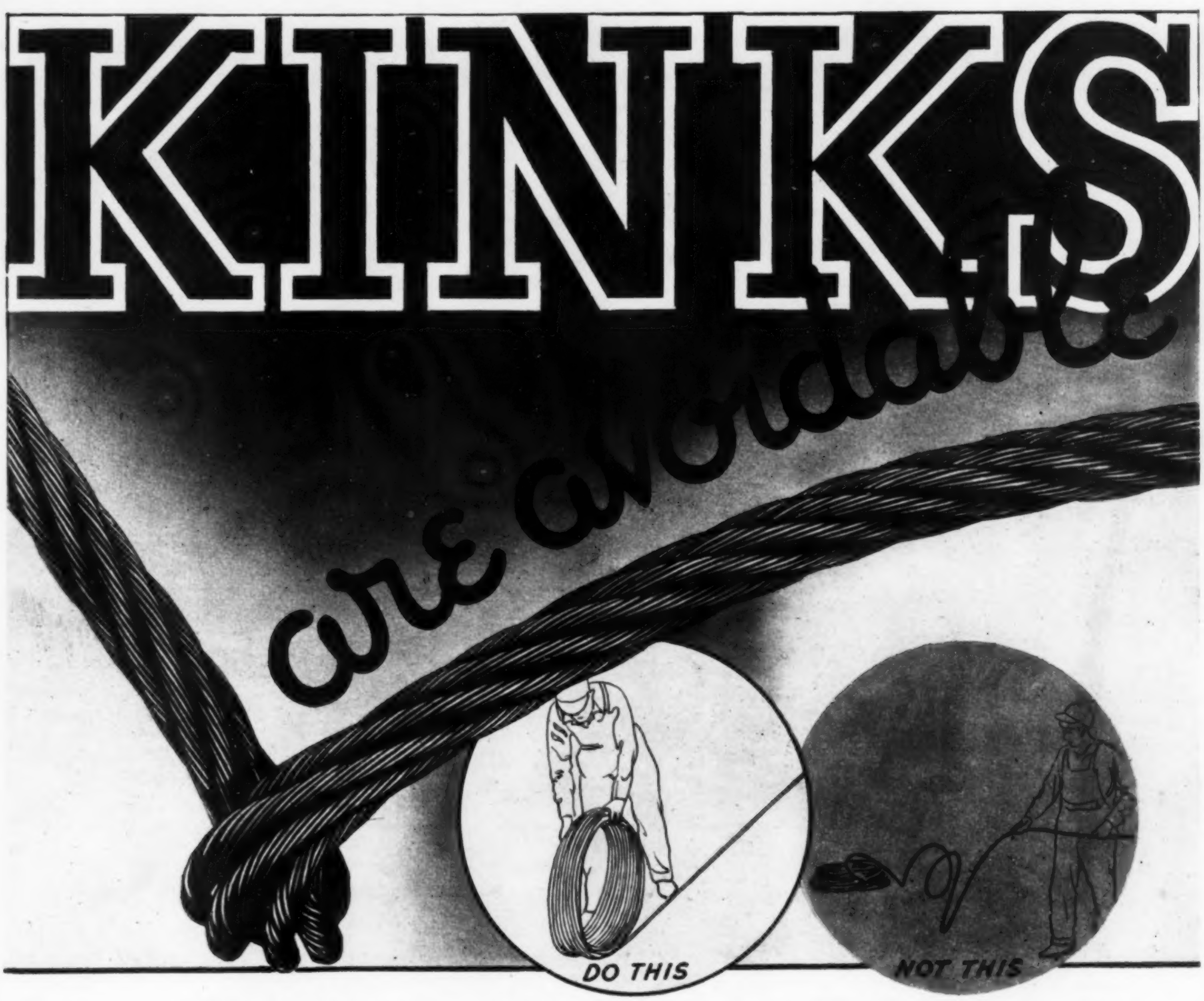

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Kinks start as loops, caused in most cases by "pulling" rope from a stationary reel and can never be satisfactorily removed. There are always thereafter "weak spots". Never "pull out" a loop, always "unfold" it. To unwind rope straight without looping "roll" the reel or coil. Write for further details about wire rope handling.

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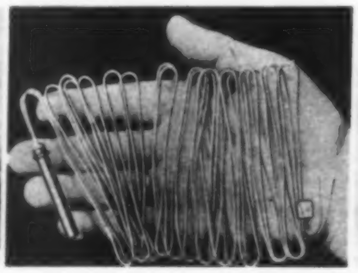
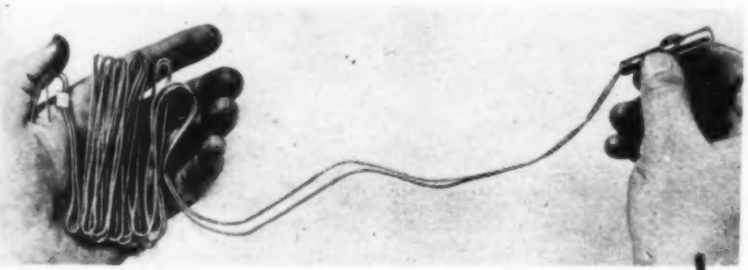
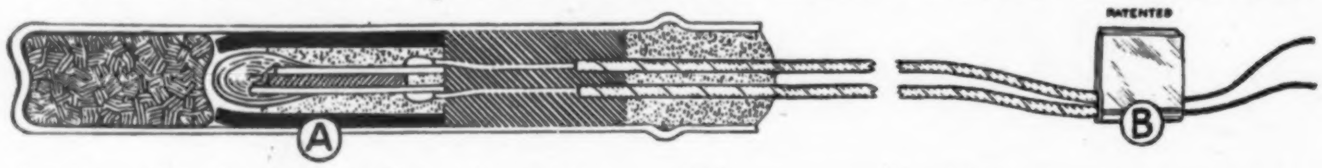




2. PROTECTION *from* STRAY ELECTRIC CURRENTS



In Atlas Electric Blasting Caps, the igniting device is scientifically insulated (A) by a fibre tube which prevents contact with the copper shell. Then the Atlas Safety Shunt (B) short circuits wire ends and (with the insulation built into the shell) provides double safety against accidental firing by stray electric currents.

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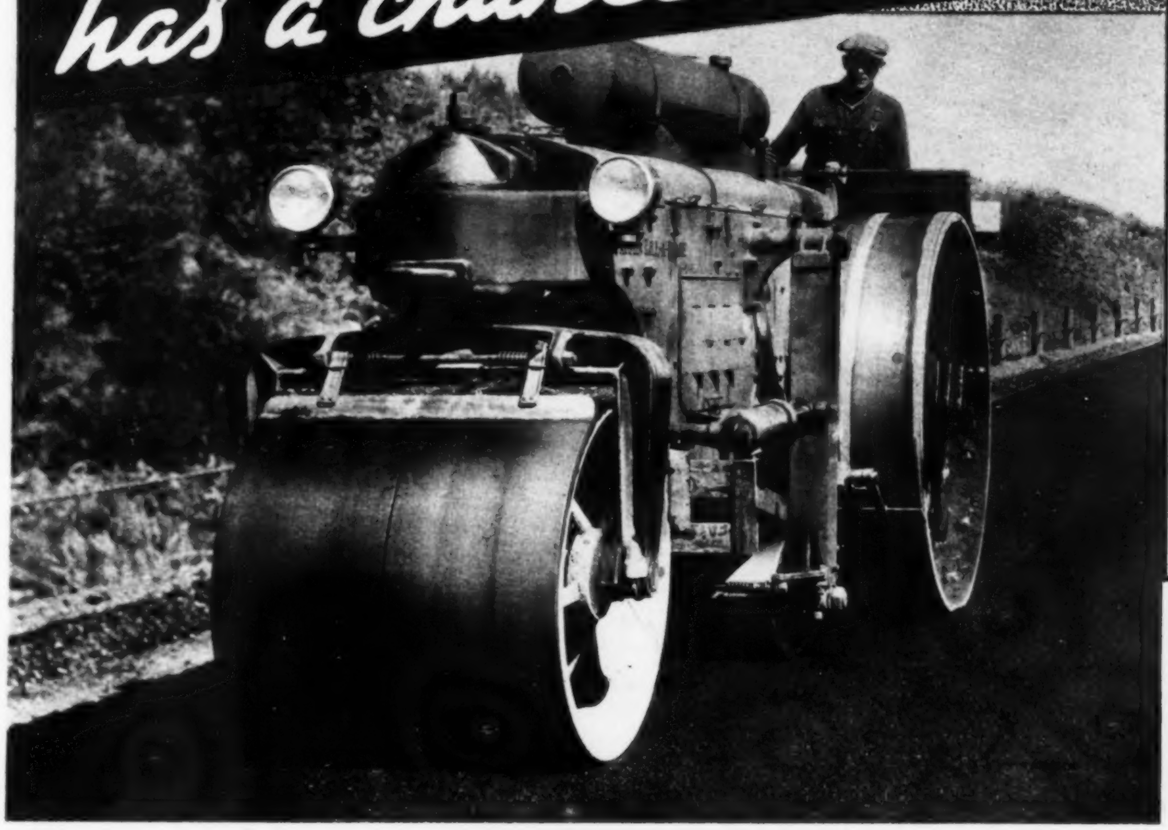
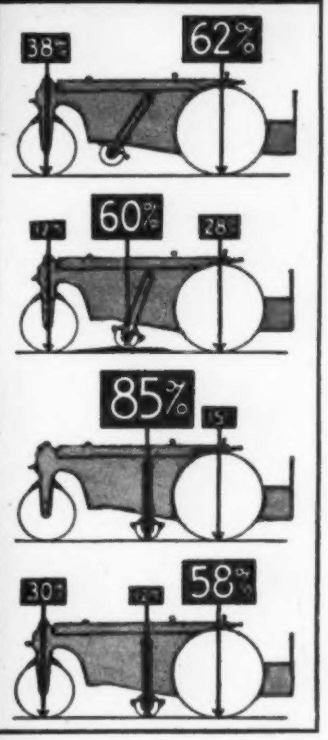
A true, smooth surface IS OBTAINED BEFORE THE BINDER *has a chance to set*





The diagrams above show why Roll-A-Plane does its work so quickly. The small center roll when set for maximum effect, concentrates up to 85% of the full weight on high areas. In any operative position, this roll has a kneading, pushing action, which relocates material standing above the true surface line.

ROLL-A-PLANE *eliminates cross-rolling saving 30-50% time*

● Tremendously important is the time element in rolling roads that have asphaltic binders. The road must be rolled quickly to a true surface and all relocation of material accomplished before the binder begins to set, otherwise there is a cracking which admits water.

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Construction Methods

ROBERT K. TOMLIN, Editor

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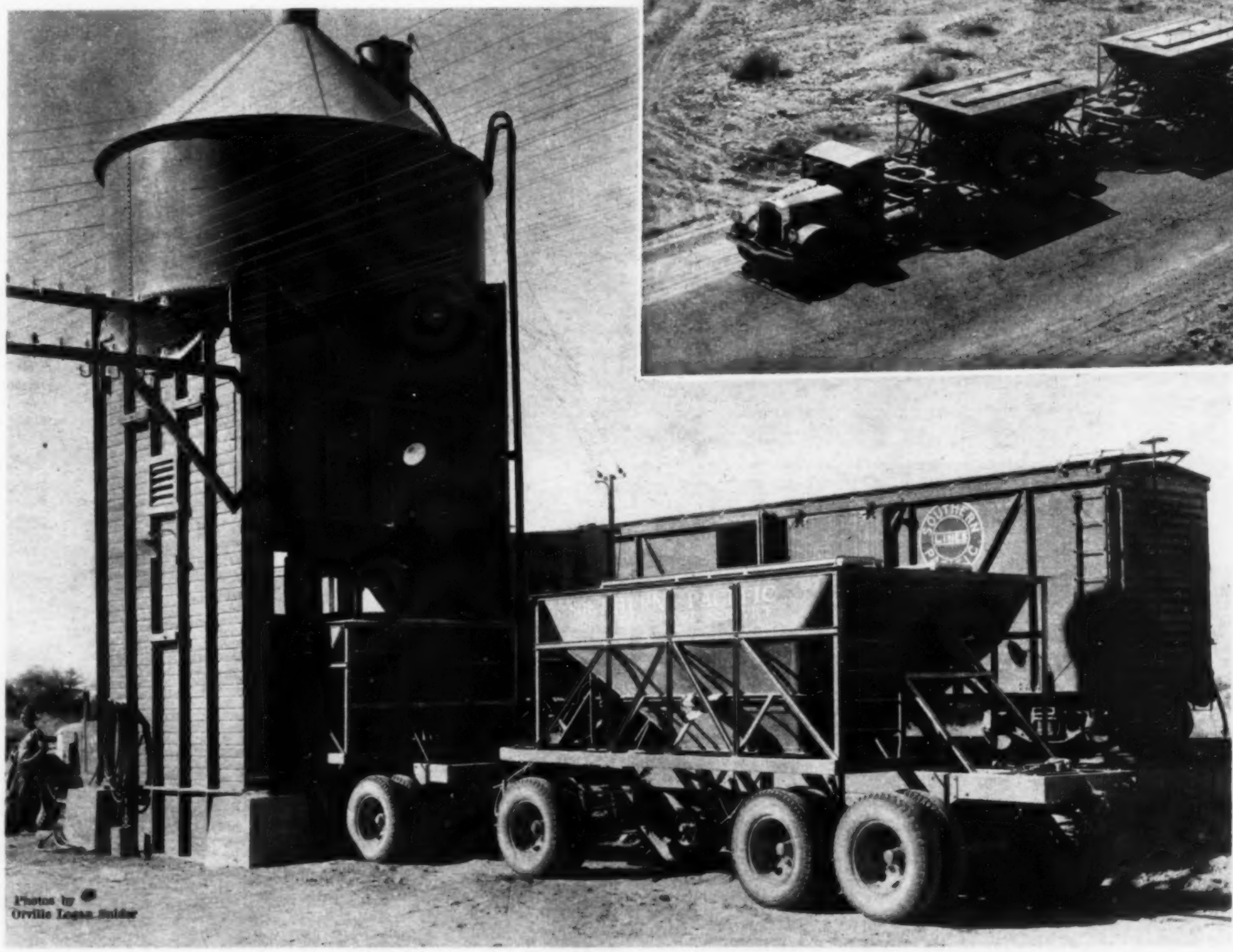
Motor Transport for CEMENT



Photos by Orville Logan Snider

WITH A FLEET of seven specially designed truck-and-trailer carriers operating throughout the 24 hr. of each day, the Southern Pacific Railway is hauling 22-ton loads of cement from a track-side bulk plant to construction jobs on the Colorado River aqueduct 30 to 60 mi. from the railroad. The route to the jobs includes a stiff 30-mi. climb up Shaver's Canyon.

A Fuller-Kinyon conveying system at the plant unloads cars of cement into a steel overhead silo from which the material is discharged through top hatches into the hopper bodies of the trucks and trailers. Three truck-and-trailer units take away a carload of cement. Each unit makes four to six round trips in 24 hr., leaving the loading plant on schedule when the driver is handed an order by the dispatcher's office.

Steel hopper bodies for the fleet were built by Cochran & Celli of Oakland, Calif., and were mounted on Trailmobile trailers and on Fageol trucks powered by Waukesha engines. Each truck-and-trailer unit rolls on 26 pneumatic tires and is equipped with airbrakes for safety on the hills.

The Metropolitan Water District of S. California directs the aqueduct work.

This Month's

"NEWS REEL"

FOUR-LEAF BASCULE SPAN *(above)* of rolling lift type, carrying 60-ft. wide roadway, provides 126-ft. channel crossing for Saugus River bridge on North Shore highway, eliminating old 26-ft. bottleneck structure between Boston and Lynn, Mass. Each bascule leaf is 81 ft. long and includes two plate girders, spaced 26 ft. 5 in. on centers, varying in depth from 4 to 11 ft. Bridge, with approach span, is about 1,250 ft. long. Contractors: Crandall Engineering Co., Boston, for substructure and McClintic-Marshall Corp. for superstructure. Built with PWA funds for Massachusetts Department of Public Works, A. W. Dean, chief engineer.

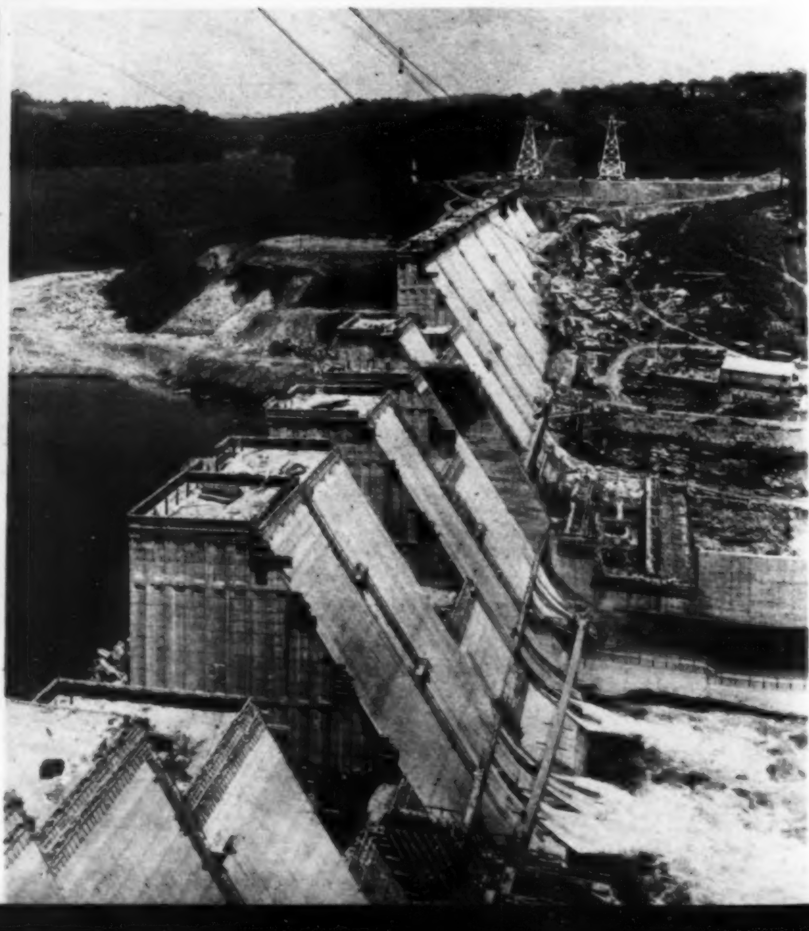
RIP VAN WINKLE BRIDGE is newest crossing of Hudson River completed between Catskill and Hudson, N.Y., 25 mi. south of Albany, under supervision of Col. Frederick Stuart Greene, state superintendent of public works. Built at cost of $2,000,000 by Frederick Snare Corp., of New York, with Harris Structural Steel Co., subcontractor for steel erection, structure with 30-ft. roadway has total length of 5,040 ft., main channel span of 800-ft., and anchor arm spans of 400 ft. Ten deck truss spans are each 330 ft. long.

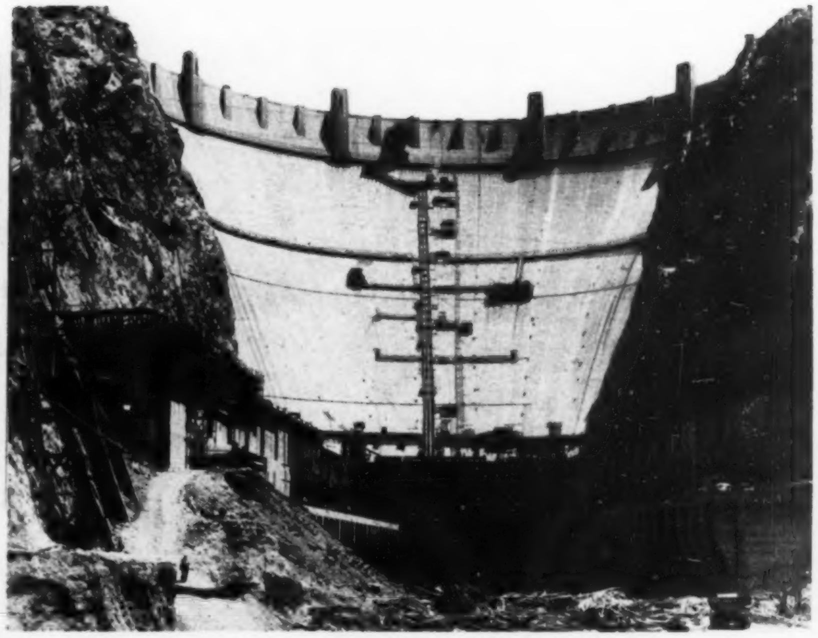
Wide World Photo

NORRIS DAM *(below)* TVA project on Clinch River near Knoxville, Tenn., is scheduled for completion Jan. 1, 1936. Several blocks of concrete structure at shore end have been concreted up to finished crest elevation. Project is being built under general direction of Dr. A. E. Morgan, chairman of Tennessee Valley Authority board.

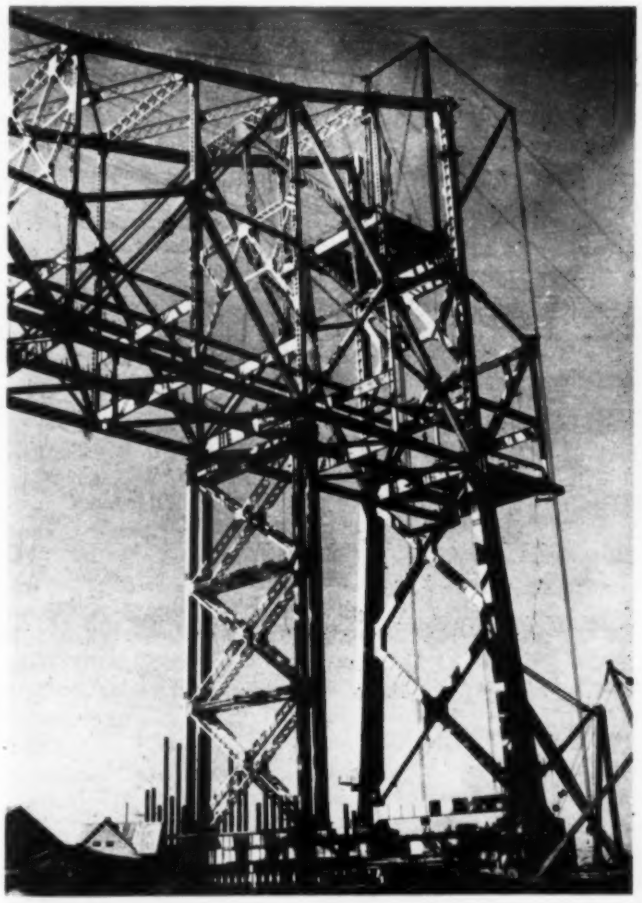
Acme Photo

HOLED THROUGH. Connection between east and west bores of Midtown Hudson tunnel, 31-ft. diameter, shield-driven subaqueous highway route with 21½-ft. roadway between New York and New Jersey, is established Aug. 2 by Mason & Hanger Co., which holds $37,500,000 contract for first tube of ultimate twin-tube project. Col. Charles S. Gleim, engineer of construction for Port of New York Authority, greets Harry Stripling, master mechanic for contractor, as he emerges from pipe joining headings.





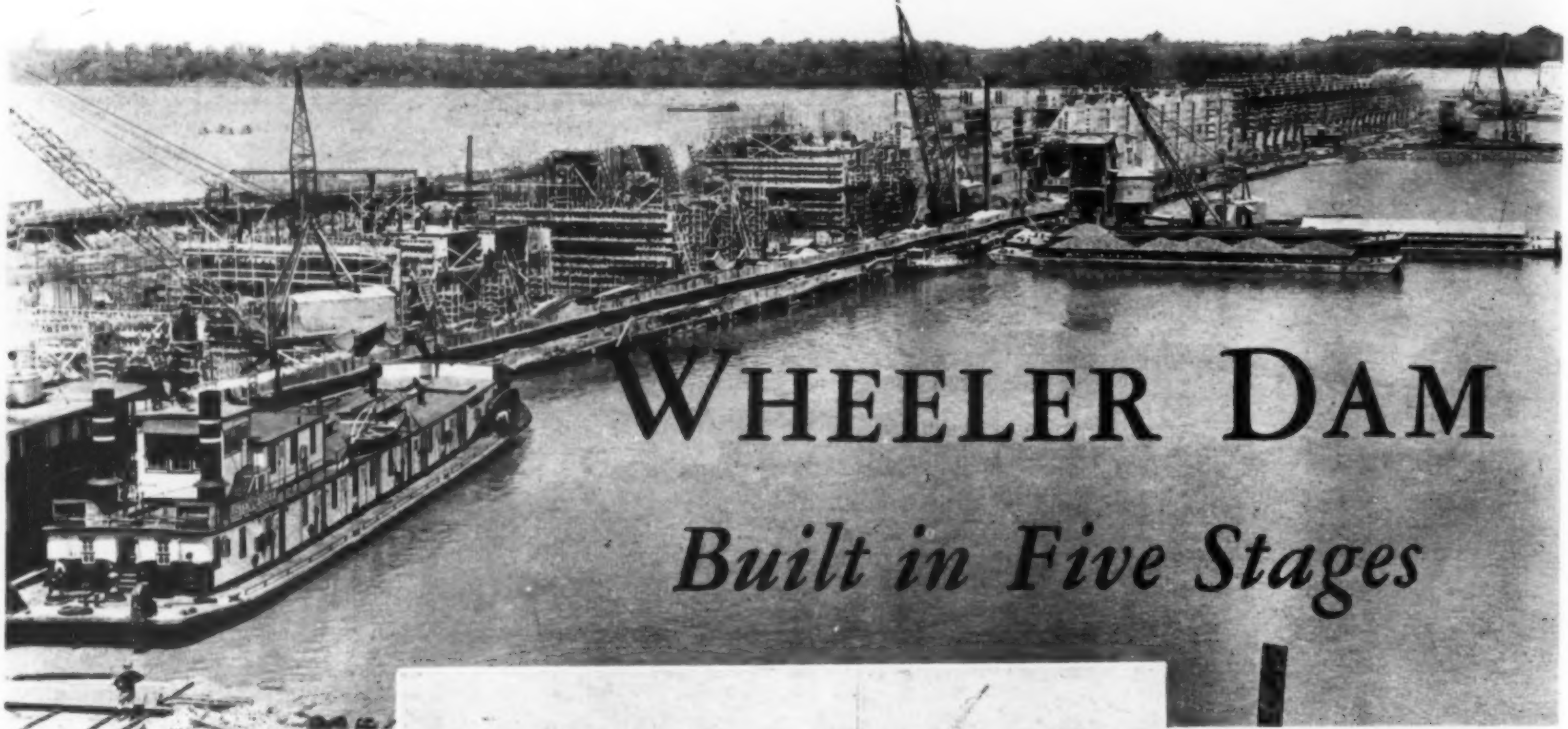
BOULDER DAM COMPLETED by Six Companies Inc. up to full crest height of 727 ft. above lowest point of foundations and more than 500 ft. above stream bed of Colorado River. View *(left)* of upstream face of U.S. Bureau of Reclamation structure containing 3,300,000 cu.yd. of concrete, taken July 25, shows four intake towers and water at depth of 300 ft. in reservoir. Power-house construction *(right)* at downstream face of dam is well along toward completion. Dam with thickness of 650 ft. at base and 45 ft. at crest was built in group of approximately 230 vertical columns 25 to 60 ft. in horizontal section concreted in 5-ft. vertical lifts.



FIRST 55-FT. PANEL of west cantilever arm of 1,400-ft. cantilever span of San Francisco-Oakland Bay bridge is extended eastward from Tower E-2 over navigable portion of Oakland harbor. Weighing 12,700 tons the 1,400-ft. cantilever span will be the heaviest ever built; it will be built without falsework by traveler cranes working from each end toward the middle. C.H. Purcell is chief engineer of project for California Department of Public Works. Contractor for steel superstructure is Columbia Steel Co.

HEAD HOUSE AND FILTER BUILDING of new Reading, Pa., purification plant conform architecturally with 18th century dwellings of surrounding rural community. Rubble stone masonry walls are built of rock from foundation excavation. Plant is one part of Bureau of Water's present $2,500,000 program to provide filtered supply of 20,000,000 g.p.d. Piping for aerators appears in foreground. William Steele and Sons Co., of Philadelphia, structural contractor; Roberts Filter Mfg. Co., Darby, Pa., contractor for filters and piping.

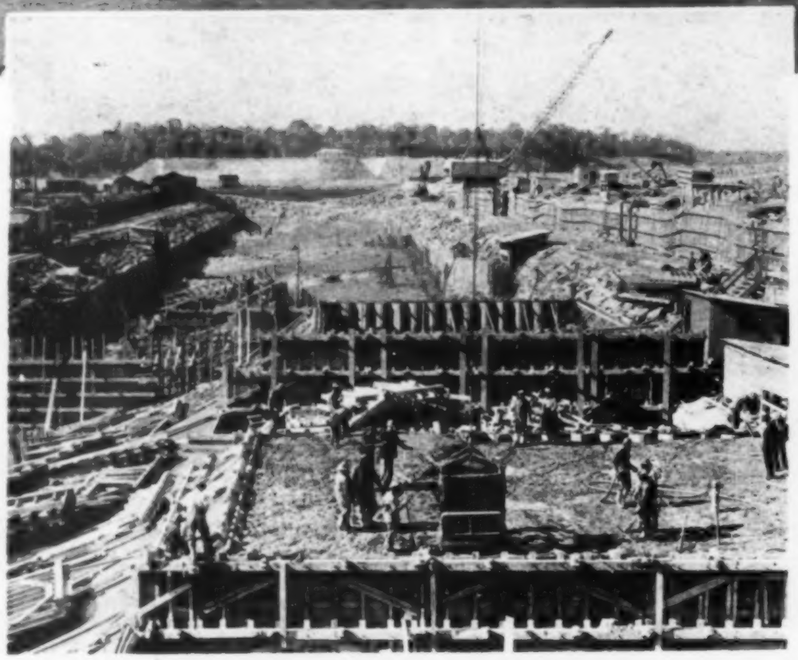
PRIVATE CONSTRUCTION RESUMES *(below)*. $20,000,000 strip mill at Bethlehem Steel Co.'s Lackawanna plant, near Buffalo, N. Y., is expected to be ready for initial hot-rolling operations by Jan. 1, 1936. Buildings and machinery for hot mill and cold mill of new plant, covering total area of 20¼ acres, rest on 14,500 H-section steel piles driven to rock by James Stewart & Co., Inc., foundation contractor. McClintic-Marshall Corp. is erecting 14,000 tons of structural steel for mill buildings.



Wheeler Dam

Built in Five Stages

CONCRETE FOR WHEELER DAM *(above)*, extending 6,400 ft. across Tennessee River, is prepared by four floating mixing plants, delivering batches to 2-yd. buckets handled to forms by gantry cranes within cofferdams.



FORMS *(left)* for concreting within cofferdam are set for 5-ft. lifts and are filled by 2-yd. buckets delivered by revolving cranes on gantries served by four floating mixing plants.

CONSTRUCTION PLANS that are being executed by the Tennessee Valley Authority to complete by September, 1936 the \$23,000,000 Wheeler dam project on the Tennessee River in Alabama, 15½ mi. upstream from Wilson dam, provide for building the 6,400-ft. long concrete structure, including power house, spillway and non-overflow dam sections, in five stages, involving first, an off-shore cofferdam from the south bank 1,425 ft. long and then four successive cofferdam extensions of 1,238 ft., 1,147 ft., 1,100 ft. and 1,004 ft. respectively.

Design of Dam—Starting from the south bank of the river the several elements of the Wheeler dam design are: A non-overflow section extending 180 ft. to the power house; power house 613 ft. long; 177-ft. non-overflow section; 45-ft. trashway; 495-ft. non-overflow section; 2,700-ft. spillway; 1,737-ft. non-overflow section; 45-ft. trashway; 60x300 ft. navigation lock; and, finally, a 270-ft. non-overflow section extending into the north bank of the river, with space, ultimately, for a 110x600 ft. navigation lock.

Designs for the 60x300-ft. lock at the north end of the dam were prepared by the Corps of Engineers, U. S. Army, under whose direction the construction of that unit was completed in 1934 (see *Construction Methods*, February, 1934, pp. 24-25). The rest of the dam, including the power house, was designed by the U. S. Bureau of Reclamation, and is being constructed by force account by the Tennessee Valley Authority.

Plan of Construction—In following the general construction plan above outlined the second cofferdam was built as soon as the rock foundation for the power house was prepared within the first cofferdam. As rock excavation in the second cofferdam was approaching completion, the third cofferdam was unwatered. The second and third cofferdams, and part of the fourth, include the entire spillway section, built in alternate 15-ft. and 30-ft. blocks.

In order to provide ample capacity to carry floods across the job, 25 of the 30-ft. blocks are first poured to a height approximately 1 ft. above the normal level of the pond of the Wilson dam, and 36 of the 30-ft. blocks are poured to a height approximately 8 ft. above that level, while the 15-ft. blocks between them are continued to full height to permit construction of the roadway which will be in service during the latter part of the job to provide access to the last cofferdam area.

The non-overflow section extending from the spillway north to the completed navigation lock will be built to full height in part of the fourth and all of the fifth cofferdams. Before these cofferdams are placed to close the stream, however, intakes for six water wheels ultimately contemplated in the power house will be available to carry flows up to ordinary floods. Meanwhile, the downstream portions of the second and third cofferdams will be removed. Floods in excess of the capacity of the power-house intakes will overtop the upstream second and third cofferdams and may then be handled through the sixty-one 30-ft. openings left temporarily in the spillway section. After the work is finished in the fourth and fifth cofferdams, the 30-ft. openings will be closed from floating mixer plants during low flows of the river. This closure work will be done in 1936 between April and November when high stages are exceptionally rare. In case floods occur in excess of the capacity of the power-house intakes, ample capacity will be available to divert the surplus flow through the temporary openings in the spillway structure.

This general plan of handling construction was based largely on the limited variation in the stage of the river due to the existence of the pond created by Wilson dam. Except during floods, the water level at the site remains practically constant. Extreme floods may produce a height 4.5 ft. above the normal pond level at El. 505.06.

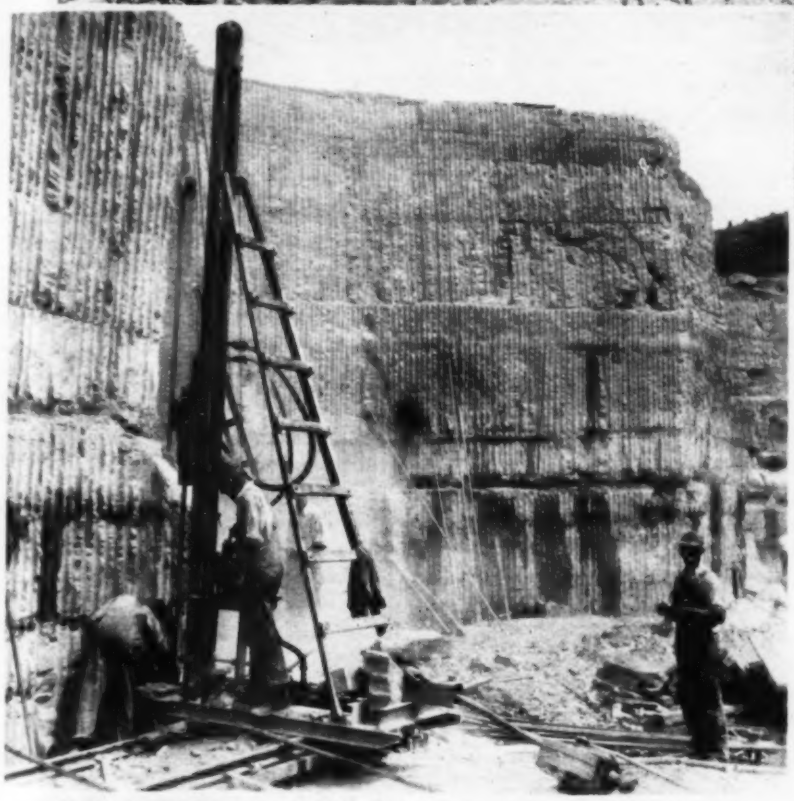
Transportation—Wheeler dam construction operations were based on water transportation for the delivery of all materials and supplies, except light shipments which might be brought in by truck over local highways. Imported shipments are brought by rail to a dock adjacent to Wilson dam, where they are loaded on barges and towed to the job.

Sand and gravel for the 650,000 cu. yd. of concrete required in building the dam and power house are obtained by dredging 35 to 50 mi. downstream from Wilson dam. Tow boats bring barges from the dredge through three locks, two below and one in Wilson dam. Cement is supplied by several manufacturers who ship by rail to a point below Wilson dam for trans-shipment by barges to the project.

Excavation of Rock Foundation—At the site of Wheeler dam the Tennessee River is confined between two rock cliffs, ledge rock extending entirely across the bed of the stream without overburden. The formation is an alternating series of nearly horizontal layers of pure limestone and a cherty, siliceous rock, with the latter much thicker than the former. Most of the few vertical joints are confined to one stratum. There are occasional cleavages, however, extending down through several layers of rock.

Numerous small cavernous fissures

POWER-HOUSE EXCAVATION within first cofferdam, showing accuracy of line-drilled vertical rock faces of recesses for water wheels. Second cofferdam extension in background.



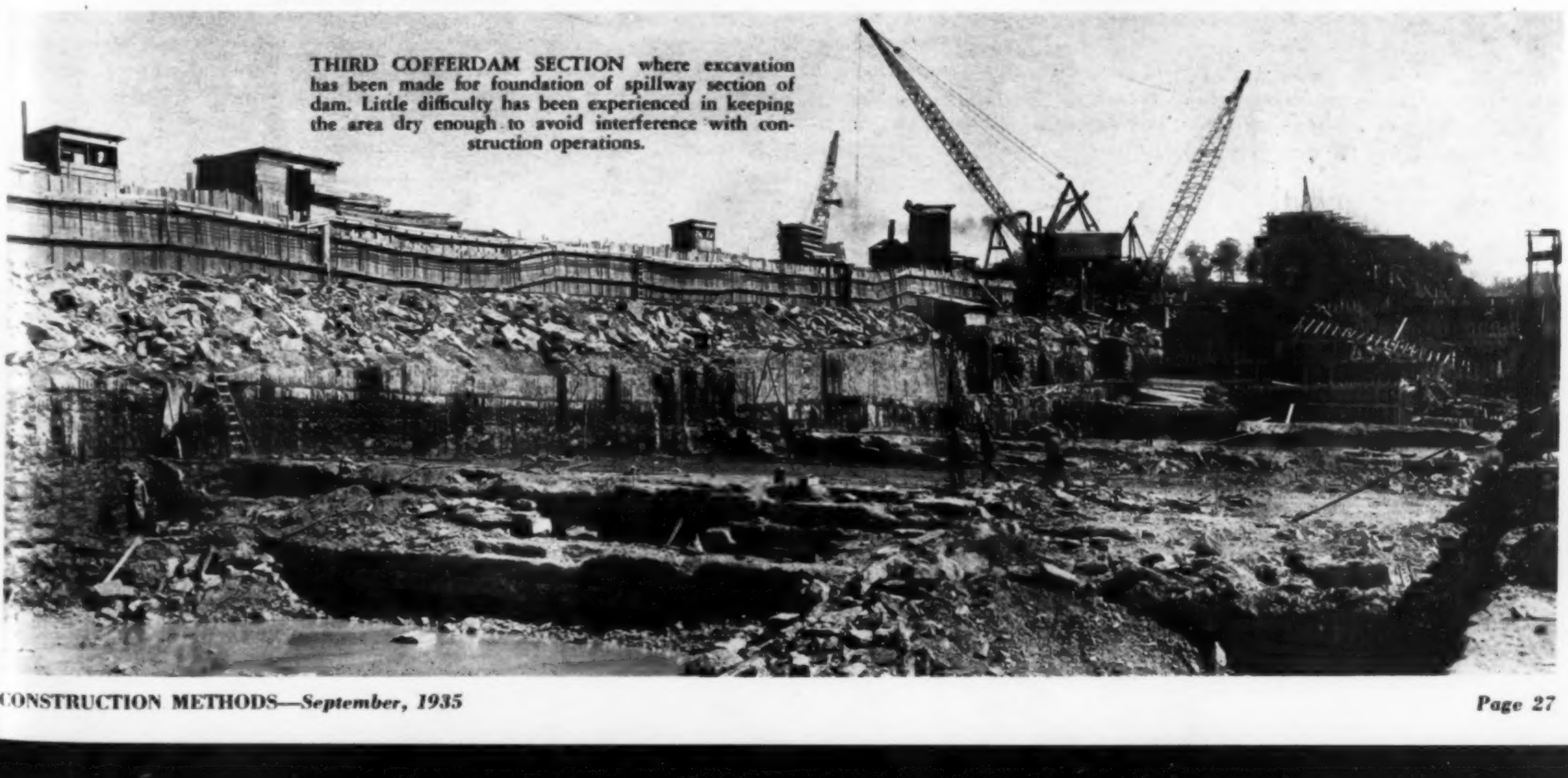
LINE DRILLING on face of rock excavation for power house. Drill on skids is set at slight incline to provide clearance for setting up machine on next lower lift.

have been uncovered, but these have been of no consequence, except two in the foundation of the draft tubes. Such caverns and the limited number of solution channels found are readily filled with concrete or grout. An entirely satisfactory foundation is thus obtained.

Original estimates were that 550,000 cu.yd. of rock would have to be removed to prepare the foundation for the dam and to excavate deep enough to provide properly for the intakes and tailrace of the power house. Present indications are that this total may be increased to 570,000 cu.yd. Some of the spoil has been used in the construction of the cofferdams and in building up a flat area along the south bank for construction plant buildings. The remainder has been wasted upstream where it will not interfere with navigation or other operations of the project.

On account of the nature of the rock, exceptional care has been exercised in the methods used in all excavation work. Except for the heavy cut required to obtain the necessary depth for the substructure of the power house, most of the excavation has been comparatively shallow. Just enough of the weathered top strata has been removed to get down to solid ledges. This has varied from 10 to 15 ft. over most of the site outside the power-house area.

Excavation for the power-house substructure extended to a depth of from 50 to 57 ft. below the existing stream bed. After considering various methods



THIRD COFFERDAM SECTION where excavation has been made for foundation of spillway section of dam. Little difficulty has been experienced in keeping the area dry enough to avoid interference with construction operations.

of drilling and shooting it was decided to avoid any blasts close to the face of the deep cuts in which the power units are to be placed. A method of line drilling to the exact shape required was accordingly developed.

Line Drilling Methods—A fleet of 12 wagon drills was installed for this purpose and to put down the holes required for blasting the rest of the excavation. In the line drilling to the contours these drills operated in sets of three to five on sectional steel track carried by portable timber runways. These drills were fitted with 2 ⅞-in. bits on 18-ft. steel. With them holes

FLEET OF WAGON DRILLS puts down holes for power-house excavation within cofferdam.

DREDGE "KENTUCKY" *(below)* operating in Tennessee River, digs, washes and separates aggregate for concrete at Wheeler dam.

were put on the line desired on 4½-in. centers to a depth of 15 ft.

As it was necessary to take out the material in from three to four lifts to get the full depth, a plan was adopted to obtain practically a vertical face where the line drilling was done to compensate for the clearance required by the drill when set up against the wall formed in the preceding lift. By tilting slightly the track carrying the drills, the latter made holes extending in 10 in. from the vertical at the bottom of each lift. When the next lift was taken out similar off-vertical holes were drilled. As a result, the finished face had a series of narrow steps in it, with the top and bottom practically in a vertical line.

In drilling and shooting the rest of the rock to be removed no blast holes were put down within 30 ft. of line-drilled faces. The nature of the material is such that careful loading broke the rock out to the line drilling with no shattering of the face of the excavation. Some pot shots had to be used to break up large pieces between the line-drilled face and the closest blasts.

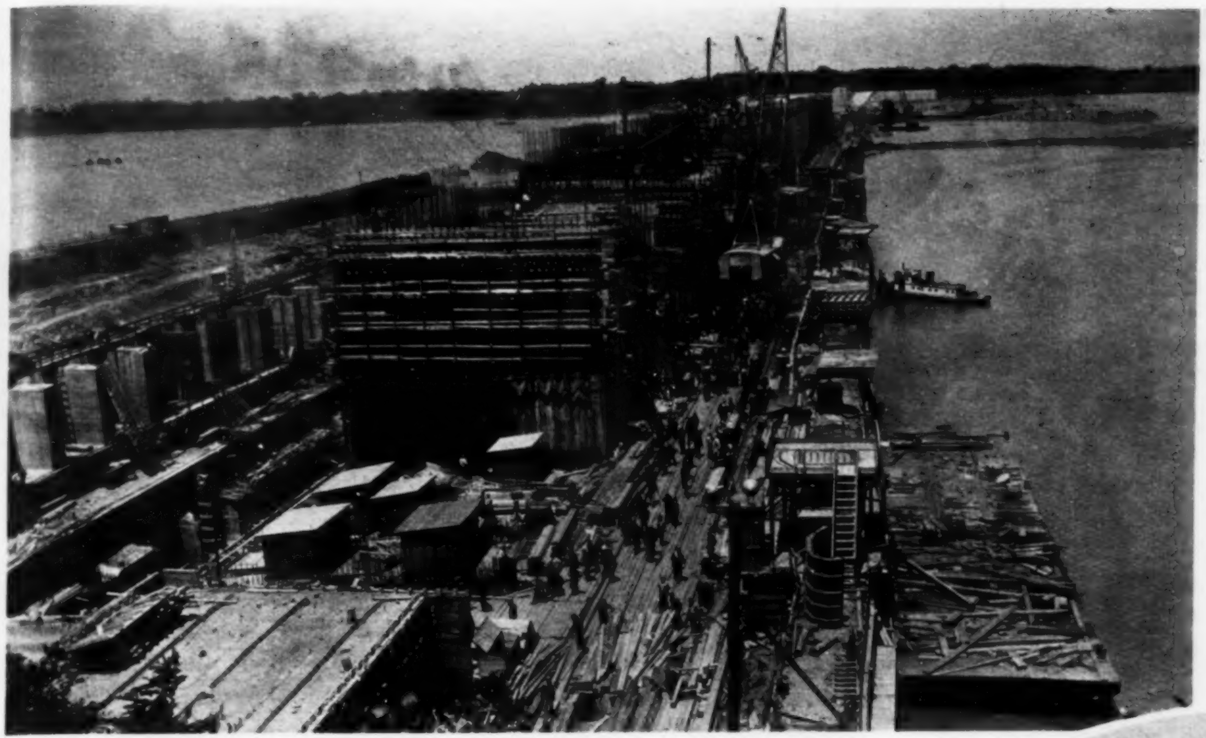
With this method the deep excavation in the stratified rock was made without any overbreakage. The saving in concrete thus obtained much more than offset the cost of the line drilling over other methods of getting the same results. But the undisturbed foundation face was even of more importance. In fact, this method worked out so well on the deep excavation that it was adopted for all face cuts, even as shallow as 6 ft., in stripping the foundation for the sections of the dam proper.

Grouting of Foundation—For the entire length of the structure beyond the deep power-house excavation, which went into very uniform rock, thorough grouting is undertaken to insure an entirely tight foundation. Two lines of 2½-in. holes spaced 20 ft. between rows and staggered 20 ft. in the rows, are put down to a depth of 20 ft. with the wagon drills. One line is 1 ft. upstream and the other 19 ft. downstream from the axis of the dam.

These holes first are tested hydrostatically at 38-lb. pressure. Practically no mud seams have been found, so that no washing out has been necessary. With few exceptions, the holes also show little or no loss of pressure when tested.

Neat cement grout is forced into the holes with a portable air-operated duplex plunger pump. While a hole is being filled, caps on adjacent holes are removed to permit flow through any seams found. Very few holes have shown any indication, however, of re-

GROUT MIXER AND PUMP used to fill rock seams under pressure of 50 lb. per square inch, producing impervious foundation for dam.



FROM SHORE END OF POWER-HOUSE, dam, when completed, will extend 6,400 ft. across river to navigation lock, in background. Note full revolving gantry crane, in center, for serving floating mixing plants and handling forms.

ceiving grout from those near them.

Beginning with 20 lb., the pressure was gradually stepped up to 50 lb. without any measurable movement of the rock. This pressure is now maintained on all holes for 10 min. In practically all cases the holes take only enough grout to fill them.

High-pressure grouting is done after a minimum of 10 ft. of concrete has been placed on the foundation. To facilitate this second sealing of the foundation, grout holes are drilled before the concrete is placed and pipes in them extended above the desired level. At the proper time the grout pump fills these holes under 100-lb. pressure. In none of these later holes has there been noticeable loss of grout.

Investigation of all questionable joints or fissures in the rock foundation have been made with 36-in. core-drill holes. With holes of this size it has been possible to lower an engineer on a bo'son's chair so he might study the exposed face of the rock. In no cases have uncertain conditions been found. These inspections also have disclosed excellent grouting effects.

Pumping Cofferdams—Considering the character of the rock surface and the weathered top strata of the river bed, comparatively little difficulty has been experienced in unwatering the cofferdams or in keeping them dry enough to avoid interference with operations. The first cofferdam was built of the Ohio River type of timber walls with earth filling. The second cofferdam was built of fills of rock spoil from the excavations in the first cofferdam, with a clay blanket on the water side to obtain tightness. As a result of experience with the two types the decision was made to build the Ohio River type for the third, fourth, and fifth cofferdams. The volume of inflow in no case has been excessive, but the timber cribs have proved more satisfactory.

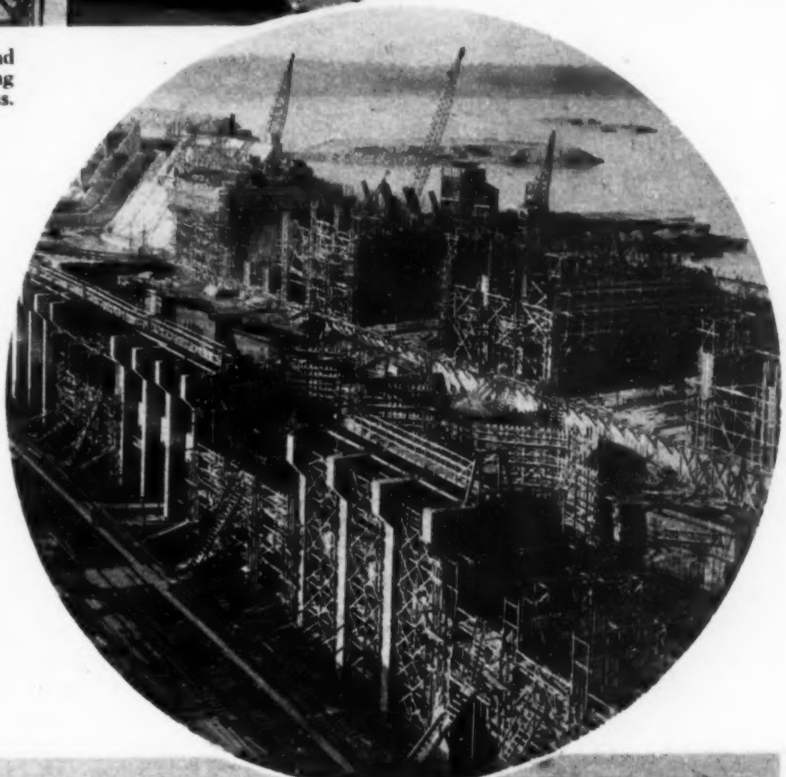
Handling Spoil—Rock excavation in the cofferdams has been handled in 10-yd. dump-body motor trucks loaded by electric shovels. These trucks operate up ramps on grades as steep as 10 per cent. They deliver either to the rock-fill cofferdam or to spoil banks upstream and downstream.

Dredging and Delivery of Concrete Materials— Sand and gravel for the concrete are produced and delivered under contract by the Cumberland River Sand Co., of Nashville, Tenn. Operations first were started in the river at a point 35 mi. below the project. When the supply at that point was exhausted the dredge was moved about 15 to 25 mi. downstream, where most of the materials are being obtained.

The material contractor operates one of the largest and most modern dredges of the type used in this country, with an average capacity of 200 tons per hour, maximum 270 tons per hour, under the local conditions. This dredge is equipped to produce simultaneously four sizes of material, all thoroughly washed and accurately sized. Sand specifications include all that passes a 4-mesh screen. Gravel is divided into three sizes: 4-mesh to $\frac{3}{4}$-in.; $\frac{3}{4}$ to $1\frac{1}{2}$ in. and $1\frac{1}{2}$ to 3 in. A crusher on the dredge for reducing oversize is rarely used. Because of an over-abundance of pea gravel in the river deposits, excess yardage must be handled to obtain the required amount of sand.

One of the main problems of the project is to maintain a flow of mate-

FORM WORK *(below)* for Wheeler dam involves an estimated total of about 12,000,000 ft. of lumber.



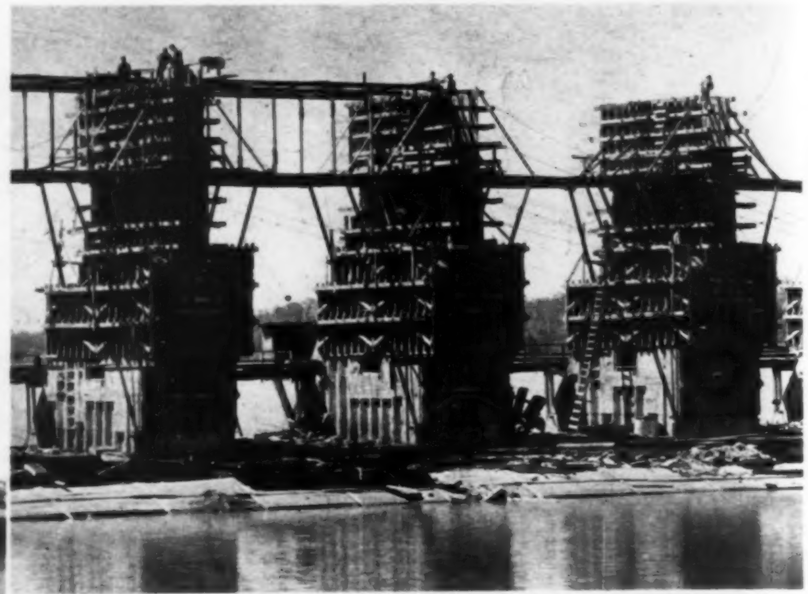
FLOATING MIXING PLANTS, mounted on steel barges moored to cofferdam walls, supply concrete for dam construction. Each of four units on job has bins, batching equipment and 2-yd. mixer.

rials from the dredge to the mixing plants so that the latter are always amply supplied. This has been done, in spite of the unavoidably wide variations in demand from time to time. Dredging and transportation plant operations also have been conducted so that not more than 10 per cent of the total quantities have had to be stored en route as a reserve against emergencies. In other words, the materials have gone from the dredge directly to the mixing plants on the job.

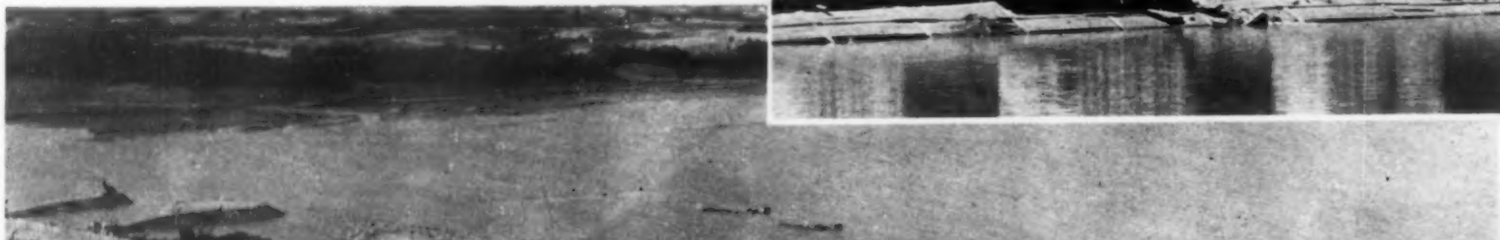
With a fleet of more than 60 steel barges and two tow-boats the contractor is confronted by some of the worst navigation conditions on the lower river. It has been necessary to operate through three locks, one of which is of antiquated size that will pass only two barges at a time. One stretch of the river channel also is so narrow that swift current requires each barge to be pulled for a distance of about ½ mi. with a tow line anchored on shore. In spite of these conditions, the material contractor has caused no delays to the work on the dam.

Mixing and Placing Plants — Lake Wilson offers a navigable depth to all parts of the Wheeler dam construction operations so that it was possible to prepare the concrete at four floating mixing plants, each equipped with a 2-yd. mixer. Each plant is moored with the mixer and of the barge against the cofferdam. Two material barges are placed on each side and a cement barge in the rear. Schedules are worked out in advance so reserve supplies of material are available on barges moored in the vicinity.

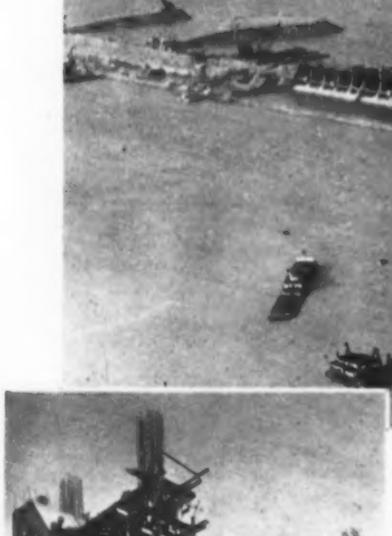
Concrete is delivered from the mixer to place in the forms in 2-yd. buckets handled by a gantry crane inside the cofferdam. Experience in operation of the gantries has demonstrated the desirability of equipping the latter with traveling mechanisms. As first installed these units were shifted by hauling themselves ahead with a line on a drum on the hoist. Due to the need of shifting more frequently than was expected, the addition of traveling mechanisms proved desirable.



PORTION OF SPILLWAY SECTION *(right)* showing wood forms and method of building alternate blocks to provide emergency floodway openings during construction.



IN LENGTH of 6,400 FT. Wheeler dam design provides for power house (at right), non-overflow sections of concrete and 2,700-ft. spillway (center). At extreme left is one of the four cofferdam extensions to the original power house enclosure.



FORMS FOR PIER to carry highway over non-overflow section of Wheeler dam.

Form Design and Construction—Another major problem of the project is the construction, erection and shifting of forms. As indicated by some of the accompanying photographs, a vast amount of forming is required, between 10 to 12 million feet of lumber being estimated. For the power-house structure and superstructure very little re-use of forms was practicable. On the rest of the job sectionalized forms have been developed which permit reuse numerous times. Since lumber is comparatively cheap in the vicinty of the job, it is, however, more economical to replace damaged forms than to repair them.

Between the power house and the lock the unusually long spillway and non-overflow sections of the dam make a stepped scheme of construction operations desirable. That is, work tapers up from excavation at the outer end of operations through the base of the dam section, the apron and the pier sections, so that a maximum of men and plant may be employed simultaneously. This program also permits standard forms to be used repeatedly for the same purpose.

Concrete is poured in 5-ft. lifts on all of the dam sections except in thin piers. Forms are accordingly made of that height. As the construction pier sections are uniform for similar locations, standardized lengths of forms are possible. Where the slope comes on side-form sections are merely extended the spillway sections, the full-length beyond the finished line of the concrete.

Somewhat standard methods of anchoring form sections for each lift by means of sleeve rods embedded in the concrete are used. Satisfactory bracing of the form for the relatively high piers carrying the roadway which surmounts the dam has been worked out. Two sets of horizontal timber struts, one midway of the height and one at the top, span the 40-ft. opening between each two piers. These hold the forms for the latter against pushing out; steel anchor rods, with turnbuckles for proper tension, are trussed across between the two sets of timber struts to keep the forms from moving inward. With this setup, form alignment for the piers has been easily maintained. Erection and dismantling with the aid of one of the gantries also is rapid and simple.

Continuous Operations—Four 6-hr. shifts are employed 6 days a week on most of the project. A system of lighting has been developed so that the efficiency of the night shifts is surprisingly close to that of the men who work in daylight. In fact, during the hottest part of the summer there is little difference between the man-hour output for the different shifts. Intricate form work and similar close operations are conducted largely in the daylight.

Personnel—A. E. Morgan is chairman and chief engineer of the Tennessee Valley Authority. C. A. Bock, assistant chief engineer, has direct charge of all TVA engineering and construction. C. H. Locher is construction consultant and A. J. Ackerman, construction plant engineer. Wilfred M. Hall is construction engineer and George P. Jessup construction superintendent on Wheeler dam.

THIN COPPER-BRONZE SHEETS are laid with lapped joints in hot bituminous paste on concrete deck of highway bridge. Note how sheets conform to shape of curb.

Thin Copper Sheets

for Waterproofing Concrete Structures

A THIN copper-bronze-sheet waterproofing for concrete structures, claimed to cost no more than ordinary three-ply bituminous membrane, has been developed in Germany and applied to 1,000,000 sq.ft. of surface on more than 200 projects in Europe during the last 3 years. The metal insulation, laid in a hot bituminous paste and protected by a bituminous top coat, forms a weathertight waterproofing which is described as completely stable against corrosion, highly resistant mechanically, and durable for the life of any structure. By a special manufacturing process, sheets as thin as four thousandths of an inch (0.004 in.) are rolled and supplied in strips for application on the job.

SPECIAL TONGS *(above)* crimp folded seam between adjoining strips. Workman then turns seam down with wooden mallet. This type of joint is preferred for some installations. BEFORE FOLDING SEAM *(left)*, joint is caulked with bituminous insulation.

In applying the copper-bronze-sheet waterproofing, the concrete surface first is given a cold bituminous prime coat which supplies a foundation for bonding the special bituminous paste spread hot upon the prepared base. The insulating sheets, consisting of copper strips 0.004 or 0.008 in. thick, are rolled into the hot, pulpy bituminous paste. Adjacent strips overlap several inches at the joints, which are sealed by the hot bitumen. During the application, the heat of the bituminous mass causes the metal sheets to expand. As the bituminous mass cools and hardens, the sheets contract and, according to the theory of the process, become more firmly bonded to the base material.

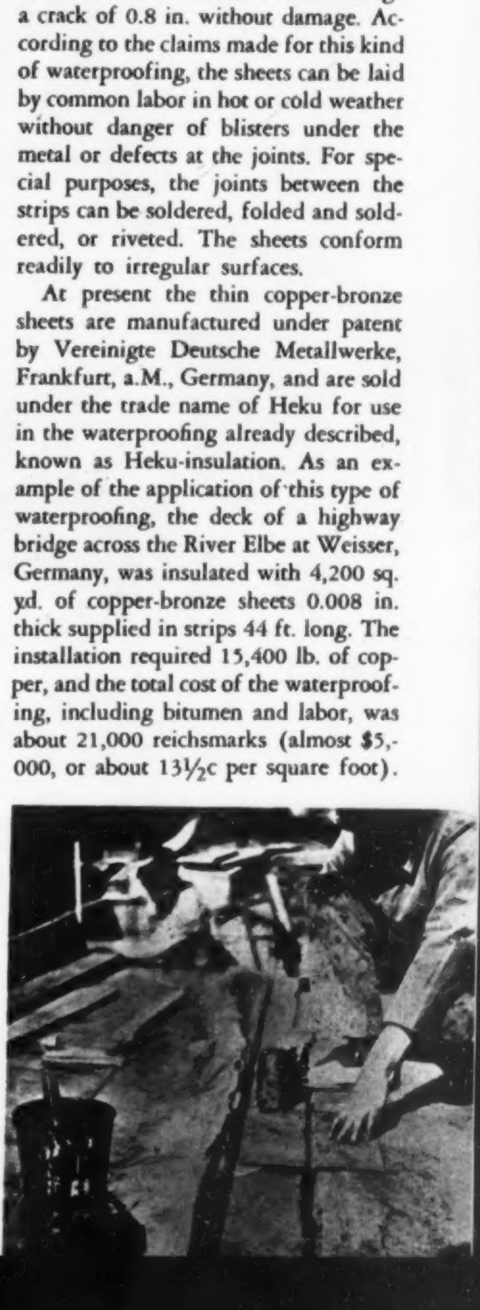
After the surface has been completely covered with metal sheets, the top of the sheets is protected by a hot asphaltic coat which can be applied by spraying. When the waterproofing is being installed on a bridge deck, the coated sheets then are covered by a protective slab of concrete on which is placed either a paved surface or ballast, depending upon whether the structure is intended for highway or railway use. The sheets have been used to waterproof culverts, tunnels, foundations and other types of structures.

LARGE CONCRETE ARCH CULVERT *(below)* is waterproofed with lapped strips of thin copper-bronze.

HOT BITUMINOUS PASTE spread under copper-bronze strips (on cold bituminous prime coat) causes sheets to expand as they are laid.

Tests of 0.008-in. sheets are reported to have shown that these sheets bridge a crack of 0.8 in. without damage. According to the claims made for this kind of waterproofing, the sheets can be laid by common labor in hot or cold weather without danger of blisters under the metal or defects at the joints. For special purposes, the joints between the strips can be soldered, folded and soldered, or riveted. The sheets conform readily to irregular surfaces.

At present the thin copper-bronze sheets are manufactured under patent by Vereinigte Deutsche Metallwerke, Frankfurt, a.M., Germany, and are sold under the trade name of Heku for use in the waterproofing already described, known as Heku-insulation. As an example of the application of this type of waterproofing, the deck of a highway bridge across the River Elbe at Weisser, Germany, was insulated with 4,200 sq. yd. of copper-bronze sheets 0.008 in. thick supplied in strips 44 ft. long. The installation required 15,400 lb. of copper, and the total cost of the waterproofing, including bitumen and labor, was about 21,000 reichsmarks (almost $5,000, or about 13½c per square foot).



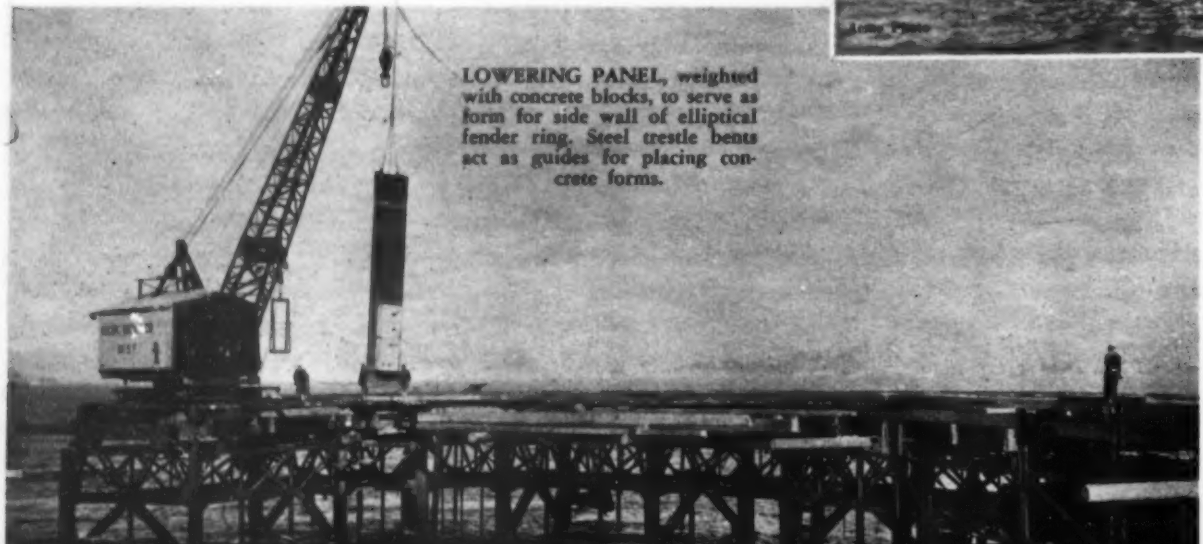
EXPANSION - JOINT INSULATION *(right)* on deck of railroad bridge utilizes deformed copper strip closely resembling types used in United States.

Subaqueous Pier Completed

in Spite of Storms and High Water

FENDER RING in form of 292 x 155-ft. ellipse, with walls of concrete 30 ft. thick, incloses south pier of Golden Gate bridge. End of 1,100-ft. access trestle in foreground.

WATER 85 ft. deep, combined with swift tidal currents and heavy seas rolling in from the Pacific Ocean, imposed extreme difficulties on the construction of the south pier to support one of the 702-ft. high steel towers of the Golden Gate bridge which will carry the world's longest cable suspension span, 4,200 ft., across the entrance to San Francisco Bay.



LOWERING PANEL, weighted with concrete blocks, to serve as form for side wall of elliptical fender ring. Steel trestle bents act as guides for placing concrete forms.

Located 1,100 ft. off shore from San Francisco, the site of the south pier, designed for construction within a protecting fender ring of concrete, had first to be made accessible by building a long service trestle, from the end of which the subaqueous work on the fender ring and pier could be carried on. The roughness of the water, with current velocities of 6.5 knots, precluded the use of floating equipment, except for dredging.

Original Plan—To the Pacific Bridge Co. a contract for the construction of the south pier and fender ring was awarded at a price of $2,600,000. Original plans for the project—revised radically as work progressed—contemplated, first, the building of the fender ring in the form of an ellipse 292 ft. long and 155 ft. wide, with vertical walls of concrete 30 ft. thick. Through an opening at the top of the ring a 90x185-ft. floating caisson for the building of the pier proper was to be towed, closure of the ring completed and the caisson sunk under air pressure and sealed into its bedrock foundation within the protecting walls of the fender ring. Difficulties encountered as the work progressed, however, led to the abandonment of the caisson method and the building of the pier by pumping out the completed fender ring and making it serve as a cofferdam.

At the site of the south pier of the bridge the bottom of San Francisco Bay is a bare, sloping ledge of serpentine rock, entirely free from overburden; ledge is at a depth of from 65 to 85 ft. below mean low water level (El.0). As originally designed the concrete pier measured 185x90 ft. at its base with sides battered to produce dimensions of 140x70 ft. at sea level. The pier base is carried about 20 ft. into ledge rock, or to about El.-100; its top extends to El. 44, resulting in a structure 144 ft. high, with 44 ft. of freeboard above mean low water.

Access Trestle—As originally built, the access trestle was a steel bent structure with its deck 15 ft. above low water; it extended from the shore 1,100 ft. out to the site of the south pier. Footings for the legs of the trestle bents were formed by blasting holes in the submarine ledge rock with small bombs. Into these holes were fitted tubular piles to receive the legs of the trestle bents. The end bent of the trestle, serving the construction of the fender ring and pier, consisted of a steel tower 115 ft. long, weighing about 50 tons, and fitted with vertical 85-lb. rails designed to serve as guides for lowering into place under water forms for the concrete fender ring wall.

Collision of a 2,000-ton vessel with the completed trestle necessitated replacement of six spans, timber bents being used instead of steel to save time.

Ledge Rock Bombed—Excavation at the pier site, using a floating dredge, was started coincident with construction of the access trestle. The water depth at the south side of the pier is 65 ft. and at the north side 85 ft. at the deepest point. The rock ledge is of such hardness that no material could be removed without blasting. A method of under-water blasting developed for the particular conditions met on this work involved the use of small pilot bombs until a sufficient depth of rock had been loosened so that a large bomb containing some 200 lb. of high explosive could be driven with the aid of a 2,500-lb. hammer into the hole well below the adjoining rock surface and fired from the surface. After the bombs had been exploded the loose rock was removed by a 5-cu. yd. bucket with specially reinforced manganese steel teeth and lips. This program of excavation, carried down to El.-100, included the area on which the guide tower was to be erected.

Fender Construction—The original method of fender construction, later

modified materially as will be explained, planned to place the concrete in one continuous pour for a height of about 80 ft. in each of 22 separate units which were to comprise the fender ring. Each unit was to be 30 ft. square in plan, ultimately extending from El.-100 to El.+15, a total height of 115 ft. The forms for these units were to consist of a stack of steel boxes each 20 ft. high, open top and bottom, assembled, one on top of the other, by riveted splices and lowered into place.

One severe storm, however, wrecked the guide tower while it was carrying a tier of three of the box forms for the first unit of the concrete fender ring and another, a second storm demolished all but 600 ft. of the access trestle. The damaged trestle was replaced with a timber structure having a deck 5 ft. higher above water level than that of the first one in order to avoid wave impact. Additional security was provided by guying the trestle bents on both sides with steel cables.

Failure of the guide tower had demonstrated the difficulty of supporting the fender on the sloping sides of the pier excavation and suggested the wisdom of having fender footings on a level surface at the same elevation (El.-100) as the pier bottom. Accordingly, a modification of the fender design was developed and the plan of construction was changed to meet it. Departing from the original plan for a continuous pour in each vertical unit, it now was decided to lay up the fender wall in courses of about 20 ft. high. The courses were to consist of blocks about 30 ft. square corresponding in plan to the original 22 fender units. Also, under the modified plan, the fender units were to be built up to El.-60 around the entire elliptical ring before any appreciable amount of exposed wall was raised above that level. This is the plan that was finally carried to completion. Because most of the steel boxes planned for use in the original concreting scheme had been fabricated, the contractor utilized as many of them as possible between El.-80 and El.-40.

Forms—The larger cross-section of footings for units which the revised plan required called for the development of a lighter form. Therefore, for that portion of the fender between El.-100 and El.-80 each form was built up as a relatively light wood and steel frame lowered into position on tricing lines. The frame alone offered a minimum of resistance to tidal currents as it was lowered. Once the frame was in place on the bottom, fastened to the adjoining units, the sides were built up with wooden panels about 5 ft. wide. These panels were weighted with concrete blocks to overcome buoyancy and were placed by divers using a fastening adapted to quick manipulation under water. All of the wooden panels and the principal members of the steel frame were stripped and reused after the concrete had set.

The bottom form for the pioneer unit was placed in two sections. The first of these encompassed the legs of the guide tower; later the first steel box was lowered and rested upon the bottom form, after which concreting of the remainder of the base and the steel box was made as a continuous pour. On all of the remaining sections the first or bottom steel box was concreted integrally with the base block.

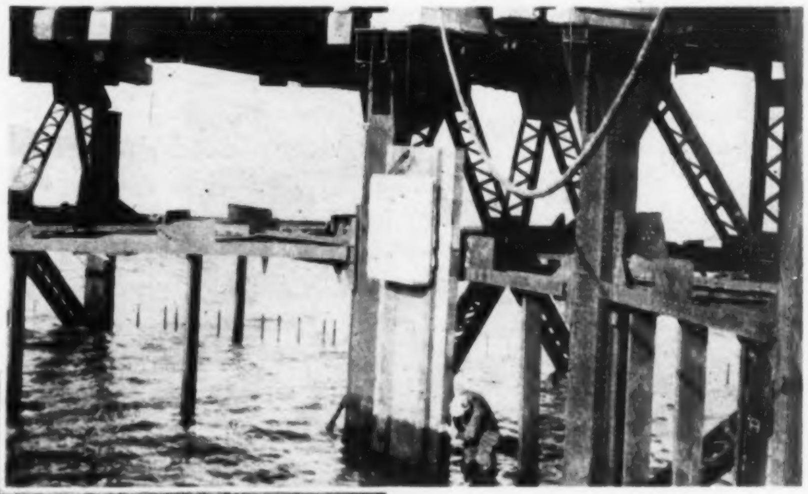
The second steel box, constituting the form for the fender wall between El.-60 and El.-40, was concreted integrally with an adjoining box so that the second course of the wall was built up of blocks 30x60 ft. in plan and 20 ft. high.

Above El.-40 an entirely different plan was used and the wall was built of blocks approximately 30x60 ft. in plan and 65 ft. high. The bents and bracing in the trestle over the fender site were so designed that they later served as guides for form panels. Above El.-40 form panels of three kinds were used: steel, weighted timber and precast concrete. The latter were made 6 in. thick and of widths to fit the spaces between the vertical guides. Precast concrete panels were particularly useful in forming up the outside of the fender where a smooth concrete face was required.

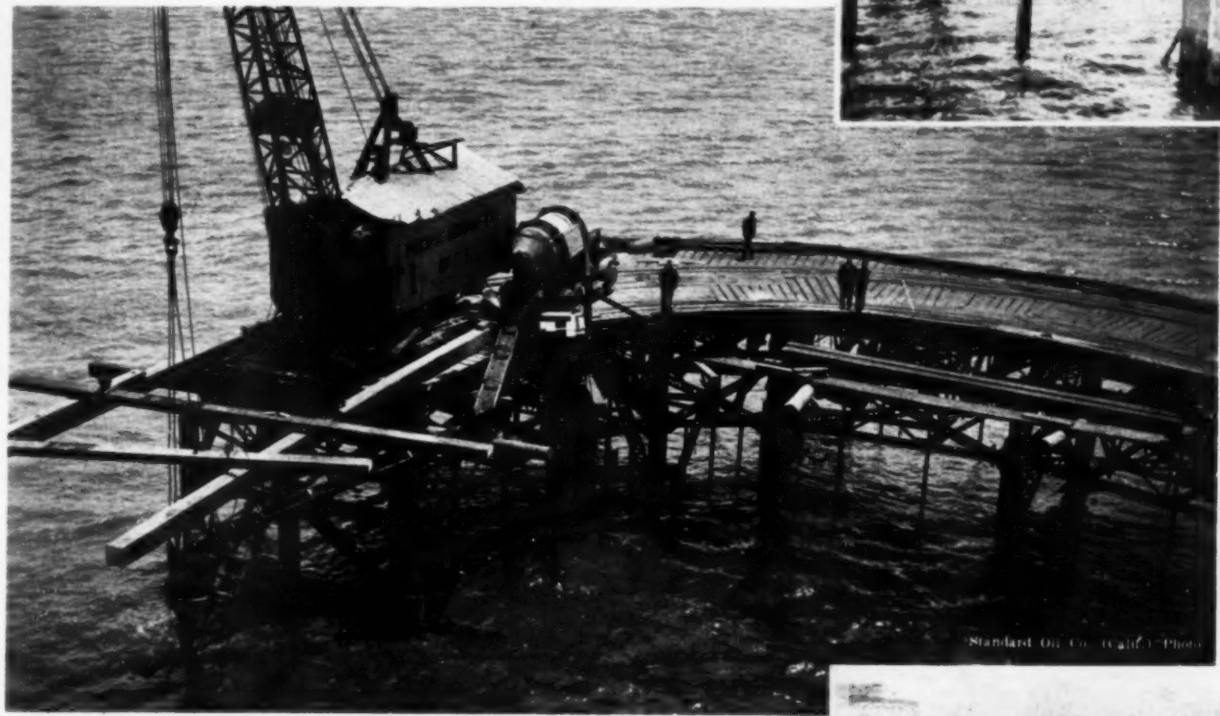
The entire fender wall was firmly bonded with keys between adjoining units and by staggering the vertical joints. In addition, the top portion of the wall above El.-2 was heavily reinforced with steel bars which tie the tops of the units together and develop arch action in case the structure is rammed by a ship.

Fender Seal and Caisson—After the first concrete was poured in the pioneer unit, progress in the fender ring proceeded according to schedule up to the point where the eastern end of the ring was concreted up to El.-40 and the remainder of the fender wall had been brought up to El.+15, the ultimate height. This was in accord with the original plan to leave the eastern end open to permit the floating in of the caisson for the bridge pier proper.

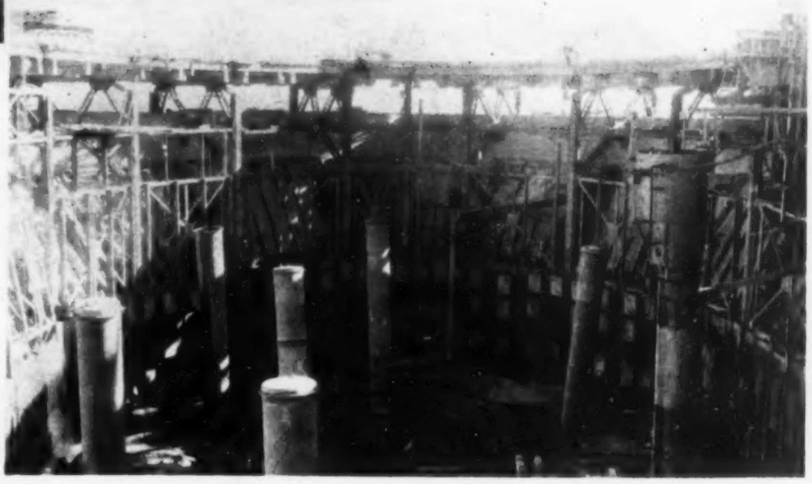
At the time the final change was made in the plan of fender construction it also was decided to bring the



TRESTLE STEEL GUIDES FORM PANEL *(above)* in its descent to place as side-wall form for fender ring concrete.



TREMIES *(left)* convey truck-mixed concrete to underwater forms for fender ring.



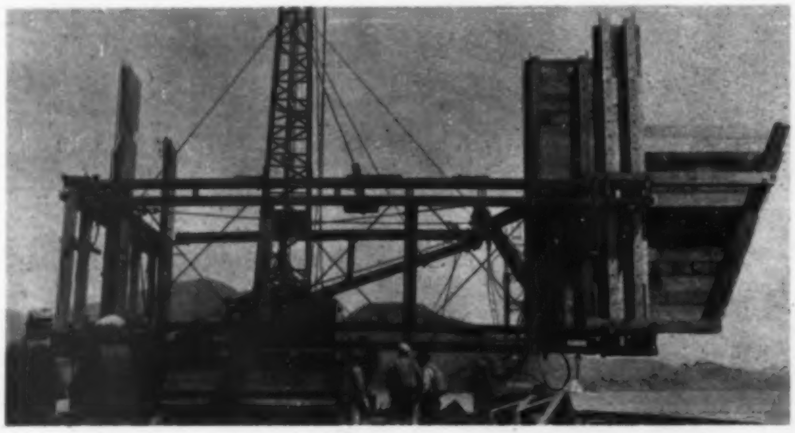
UNWATERED FENDER RING *(below)* with shafts of inspection wells rising above seal concrete surface.

concrete seal up to El.-65 instead of only to El.-80, as originally intended. Before concrete was poured in the seal, eight inspection wells consisting of steel semispheres 15 ft. in diameter, from which access shafts 6 ft. in diameter extended upward, were distributed over the foundation so that after the seal had been poured the area beneath these steel chambers still would be accessible for inspection of this much of the rock surface.

On Oct. 8, 1934, with all skeleton steel bents removed from the east end of the fender, the caisson was towed to the site, safely moored within the fender enclosure and preparations immediately were begun to close the east end of the fender ring. Before this could be done, however, another storm caused the caisson to batter the steelwork and concrete of the fender with such force as to threaten to wreck itself within the fender enclosure. The contractor was forced to remove the caisson at once and to abandon its use in construction of the pier.

The fender ring was completed on Oct. 28 and by Nov. 4, the tremie blanket of seal concrete had been raised to El.-65. In lieu of using the caisson the contractor planned to pump out the fender enclosure, using the fender wall as a cofferdam. To do this it was considered wise to add more concrete to the seal, raising its upper surface to El.-35. Further changes were made in the shape of the pier shaft above El.-35 to distribute the load over the base of the entire fender in addition to the base of the pier. The original bearing area of the pier, 15,596 sq. ft., was thus increased to 24,000 sq. ft.

ROCK FOUNDATION for pier under semi-spherical steel inspection chambers 100 ft. below water surface. *(Left to right)* Harry Erickson, underwater superintendent, Pacific Bridge Co.; Russell G. Cone, resident engineer, Golden Gate Bridge and Highway District; and Jack Graham, superintendent, Pacific Bridge Co.



FRAME for footing form of fender ring, with some end wood panels in place ready for lowering. Remaining panels placed by diver.

Pier Concreting—On Nov. 27, 1934 the pier area within the fender wall was unwatered; the wall was found to be remarkably tight and very little pumping was needed to keep the bottom dry. Within the open cofferdam made by the fender ring and the concrete seal, forms for the pier proper were built up and filled with concrete. On Jan. 3, 1935, the pier had been concreted to its final height, El.+44. Quantities of concrete were: In fender wall, 76,300 cu. yd.; in seal and pier, 70,000 cu. yd. Rock excavation for pier and fender required 45,000 cu. yd.

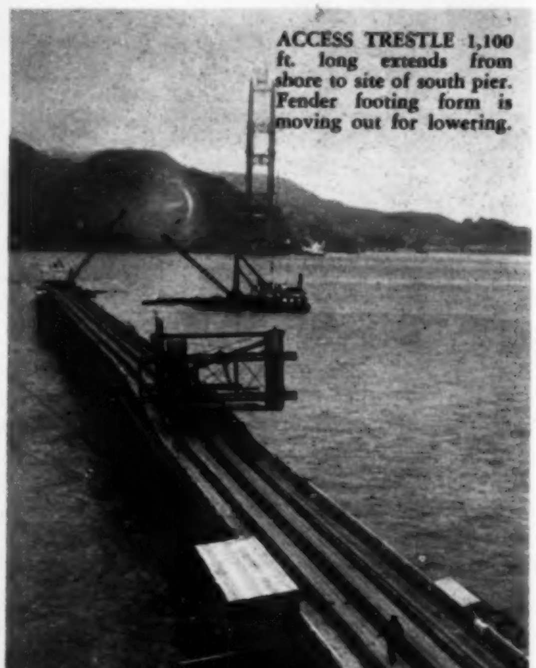
Concrete was batched at the plant of the Pacific Coast Aggregates Co. near the bridge site and was delivered by trucks which mixed in transit. In all concrete put in the fender and pier 7 sacks of cement were used per cubic yard. High-silica cement was selected for the pier and fender to insure workability of the concrete where large tremie pours were made. Tests indicate the cement will show a high degree of resistance to sea water.

Personnel—The bridge is being built by the Golden Gate Bridge and Highway District. Joseph B. Strauss is chief engineer, Clifford E. Paine is principal assistant engineer and Russell G. Cone is resident engineer.

Officers of the Pacific Bridge Co., contractor for the south pier, are: C. F. Swigert, president; Philip S. Hart, vice-president; and W. G. Swigert, secretary-treasurer. The work in the field for the contractor was under the immediate direction of Philip S. Hart and Jack Graham, superintendents. Chris Hansen was chief diver.

FENDER TRESTLE BENT ready for lowering to serve as bracing for forms. Note vertical guide channels for form panels.

STEEL BOX FORM UNIT for fender being lowered to place form end of access trestle.

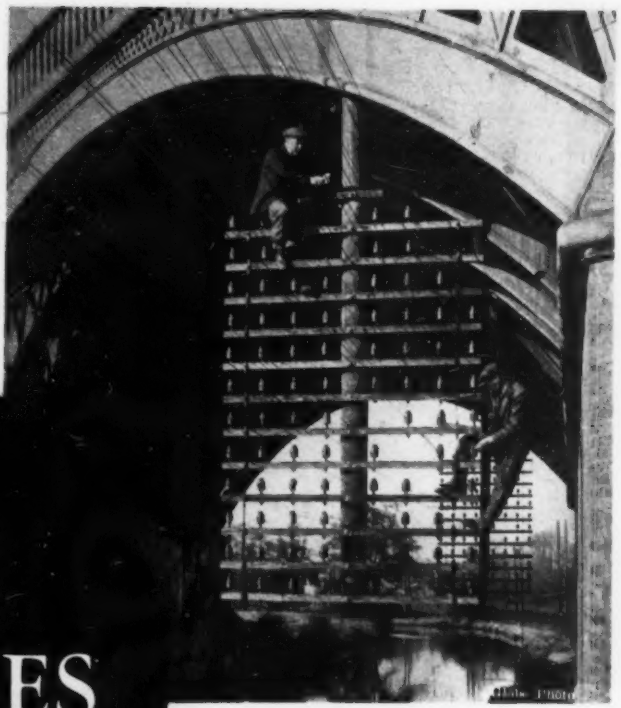


ACCESS TRESTLE 1,100 ft. long extends from shore to site of south pier. Fender footing form is moving out for lowering.

JOB ODDITIES

A Monthly Page of Unusual Features of Construction

STRONG-ARM METHODS on road work in British South Africa, where battalion of natives with pick and shovel shape a roadside ditch.



INVERTED POLES carry telephone lines under English bridge. What happens to telephone service in event of serious flood is matter of conjecture.

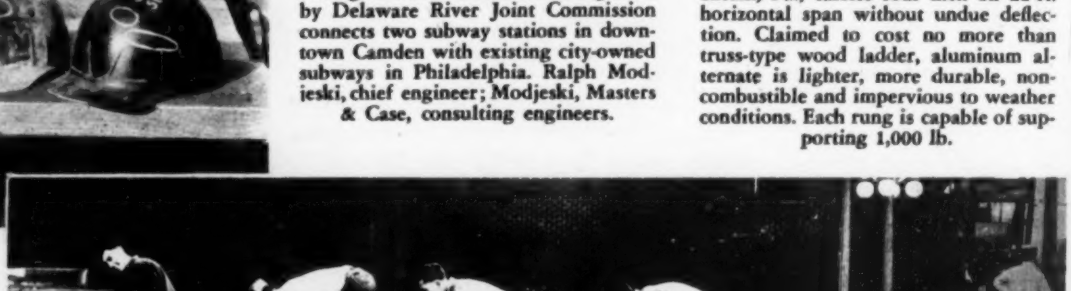
MADE WORK for Canadians. At about 20 per cent increase in cost for structural steel, frame of dominion public building at Hamilton, Ont., utilizes riveted members made up of plates and angles in order to provide work for local fabricating shops and for Canadian mills, equipped today to roll only these shapes. Structure covering plot about 290x120 ft. is being erected to height of six stories, with provision for later addition of two more stories. W. H. Yates Construction Co., Ltd., of Hamilton, holds general contract worth $1,650,000. Hamilton Bridge Co., Ltd., subcontractor, furnishes and erects steel.

BALLAST RETAINERS on Delaware River bridge approaches of Philadelphia-Camden high-speed rail transit line consist of bricks cast in concrete slab to keep track ballast from sliding downgrade. Rail transit line being built by Delaware River Joint Commission connects two subway stations in downtown Camden with existing city-owned subways in Philadelphia. Ralph Modjeski, chief engineer; Modjeski, Masters & Case, consulting engineers.

Photo from Mine Safety Appliances Co.

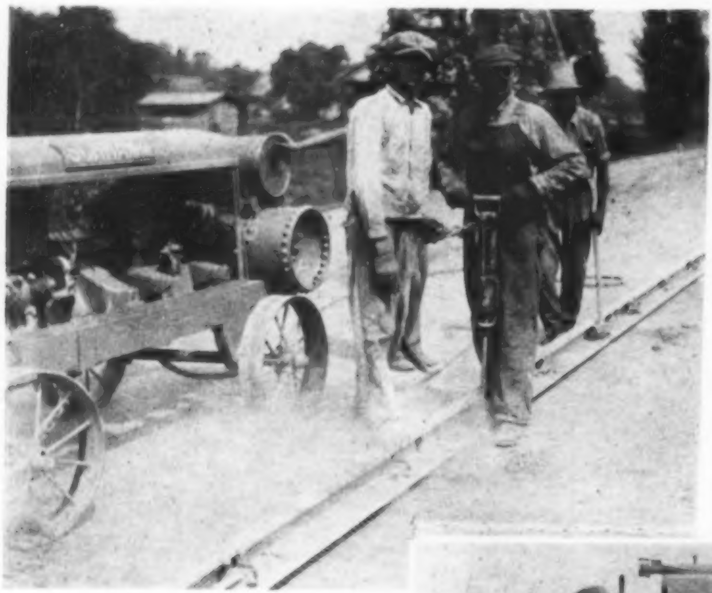
SKULLGARDS live up to their name by saving five men from serious head injury on one sewer contract. None of the men lost a day's work, although the hardshell hats *(left to right)* were struck by a steel rib, by a 25-lb. screw jack that fell 2 ft., by an 8½-lb. hardwood block that dropped 11 ft., and, in the case of the last two, by grout pipes in low tunnels.

24-FT. ALUMINUM LADDER *(below)* made by Burket Mfg. Co., of Tarentum, Pa., carries four men on 22-ft. horizontal span without undue deflection. Claimed to cost no more than truss-type wood ladder, aluminum alternate is lighter, more durable, noncombustible and impervious to weather conditions. Each rung is capable of supporting 1,000 lb.



OLD BRICK PAVE

by Resurfacing



HOLES FOR FORM STAKES are drilled in old pavement through stake eyes in flange of steel form.

TO SALVAGE and improve an 11-mi. section of old brick pavement on U.S. Route 60 the West Virginia State Road Commission resurfaced the brick with reinforced concrete and built monolithic shoulders to widen the pavement to 20 ft. Some unusual methods were developed to obtain superelevation with forms set on the old pavement.

Basis of Improvement—U.S. 60, one of the scenic highways of the state, connects two of West Virginia's principal cities—Charleston and Huntington. Between Culloden and Barboursville it follows an abandoned right-of-way of the Chesapeake & Ohio R.R. About 1917 Cabell County paved this section with brick on a 5-in. concrete base. The paved section was 16 ft. wide, which was adequate for the traffic at that time, but as vehicles became heavier and more numerous, it was seen that not only was a wider road needed but that the pavement was not strong enough to carry the loads to which it was subjected. Consequently, the State Road Commission advertised for bids for widening and resurfacing.

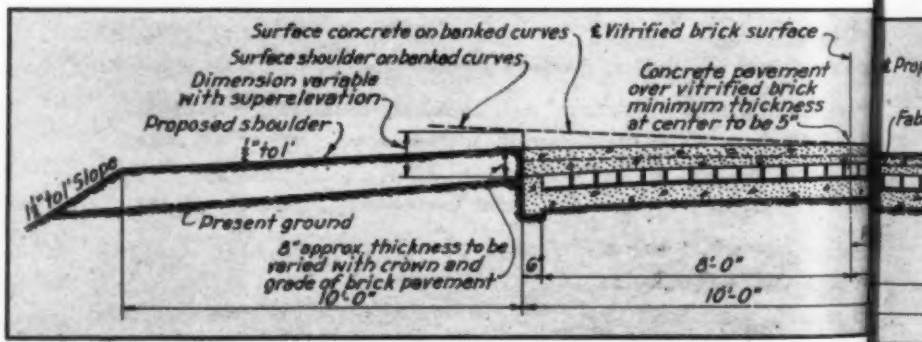
Bids were received for resurfacing with different kinds of bituminous materials for a part of the road and for reinforced concrete for the remainder. When the bids were tabulated it was found that it would be cheaper to resurface the whole length of the project with concrete than to use part bituminous and part concrete pavement. All bids, therefore, were rejected, and the project was readvertised for reinforced concrete only. W. A. Wilson & Sons, of St. Marys, W. Va., were the low bidders and were awarded the contract.

Design of Resurfacing—Three different sections were used for the paving. First, where the brick pavement had not broken down, it was covered with a minimum thickness of 5 in. of reinforced concrete, this thickness increasing to 8 in. as the edges of the old pavement were approached. The portion beyond the edge of the old brick was made 8 in. thick. Second, where the old pavement had been removed and traffic-bound gravel had been used for surfacing, a uniform 7-in. section was used. Third, where the new pavement was to be placed on earth, an 8-in. uniform thickness was constructed. The new concrete was laid directly on the old brick without any attempt either to prevent or obtain a bond between them.

Slab reinforcement consisted of wire mesh weighing 43 pounds per 100 sq. ft.. Additional reinforcement of $\frac{1}{2}$-in. round bars 3 ft. long, spaced 5 ft. apart, was placed over the edge of the old

STRAIGHT-EDGE checks joints in steel forms set on existing road.

CROSS-SECTION *(below)* of reinforced-concrete resurfacing and shoulder widening on existing 16-ft. brick pavement.



ENGINEERS TAKE CROSS-SECTIONS on old pavement after forms are set to determine quantity of concrete for which payment will be made.

AT EXPANSION-JOINT LOCATION workmen drill holes in old pavement for stakes to support joint during construction.

VEMENT SALVAGED

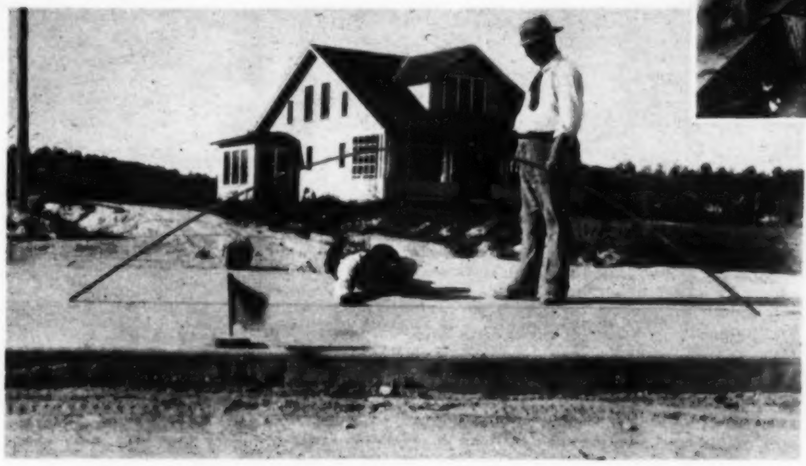
ng With Concrete

SUPERELEVATED CURVE *(right)* requires two forms in combination, one placed upon the other, at outside edge of pavement. Stakes are driven through flanges of both upper and lower forms.

slab as insurance against cracking at that point.

Construction Operations — As the traffic between Huntington and Charleston is heavy and as there were no good detours, the resurfacing was built half at a time. Grading for the widening and some relocation was completed two years in advance of pavement construction.

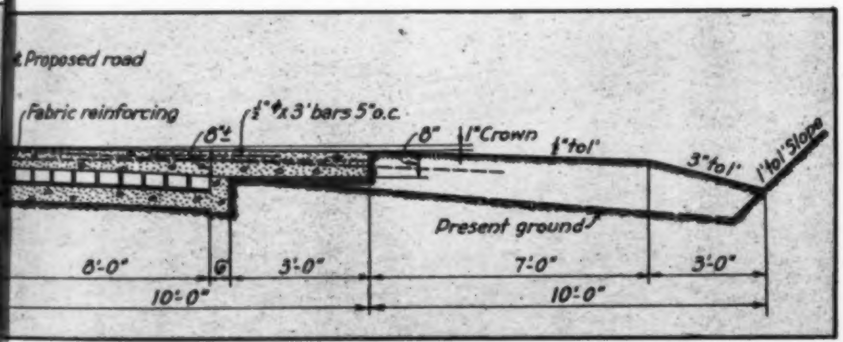
To obtain a true surface and straight alignment, considerable care had to be used in staking the forms. As the first step, the center line of the pavement was established. After forms for the center joint of the pavement had been placed along the established center line, jackhammer holes were drilled through the brick and the concrete base, the drill steel of the jackhammer operating through the stake hole of the form. Form stakes then were driven through these holes. After the center form had been staked, the outside form was set and both forms were tested for both horizontal and vertical line. It was necessary to use shims under the forms to take up irregularities in the grade of the old pavement.



PIANO-WIRE BOWSTRING, stretched between ends of bent stick, checks surface of completed pavement.

the job, and combinations of two of these sizes were found adequate for all superelevations. As the stake holes in all forms were equally spaced, the same stakes secured both the upper and lower form when two were used in combination.

Realignment of the road in places caused the form stake for the edge of the new slab to come within an inch of the edge of the old pavement. As it was impossible to drill a hole this close to the edge, the stake was driven



WIDENED TO 20 FT. and resurfaced with minimum 5-in. thickness of reinforced concrete, highway now provides pavement adequate for modern traffic needs.

16-FT. BRICK PAVEMENT on 5-in. concrete base, broken down by heavy traffic and vehicle loads, is salvaged by resurfacing with reinforced concrete .

Similarly a transverse line of stake holes was drilled for each expansion joint. Four holes were drilled in line at each joint location, with one additional hole off line the thickness of the joint filler. The odd hole was drilled on the side nearer the mixer.

Superelevating Curves—As the old road had not been superelevated, it was necessary to use thicker concrete to obtain superelevation on the curves. The contractor had 5-, 7- and 8-in. forms on outside the pavement and was bent until the form was in line.

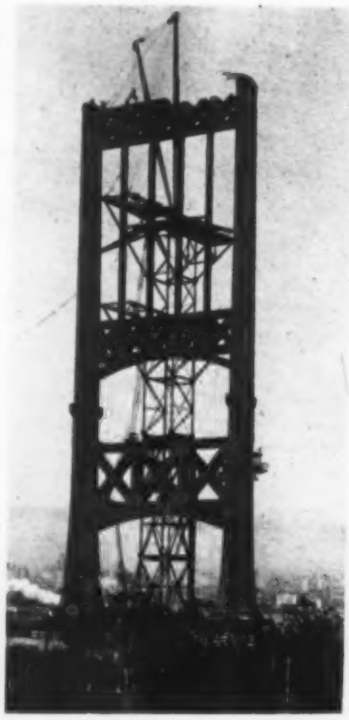
Instead of an ordinary straight-edge, a piano wire stretched as a bowstring was used with good results to check the surface of the pavement. As West Virginia buys its concrete pavement by the cubic yard instead of the square yard, it was necessary on this project to cross-section the subgrade at 10-ft. intervals, five points being taken at each section.

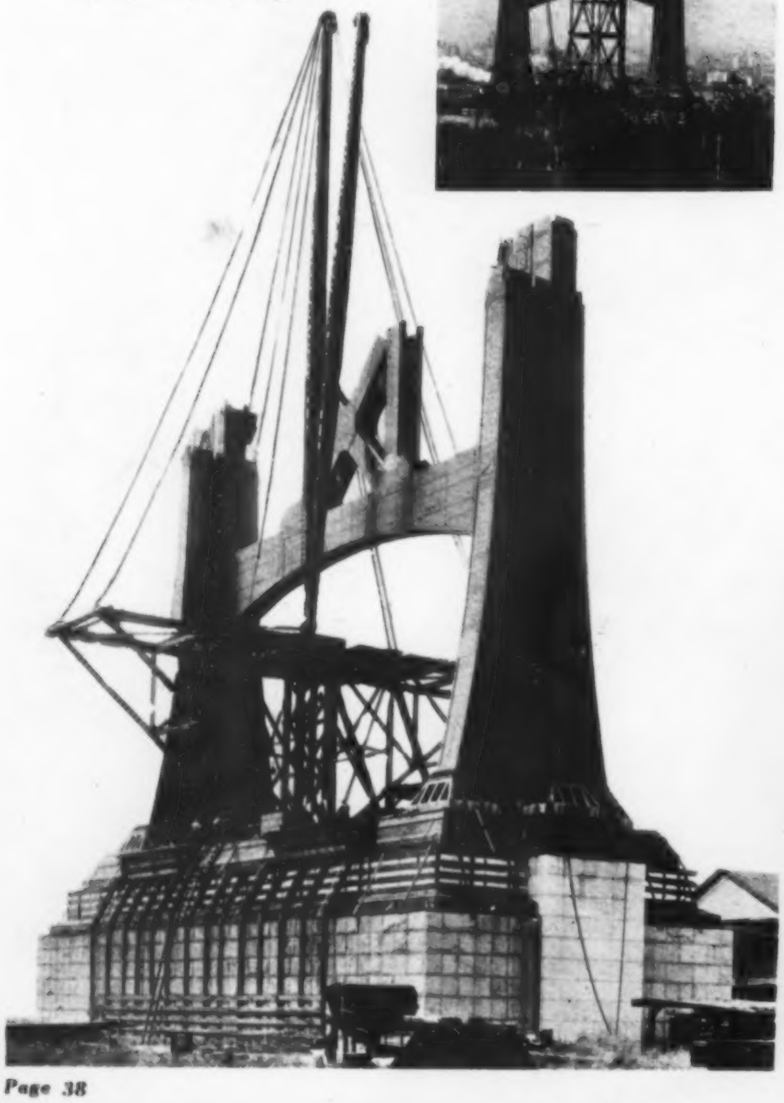
Getting Down to DETAILS

[Close-up Shots of Job Methods and Equipment]

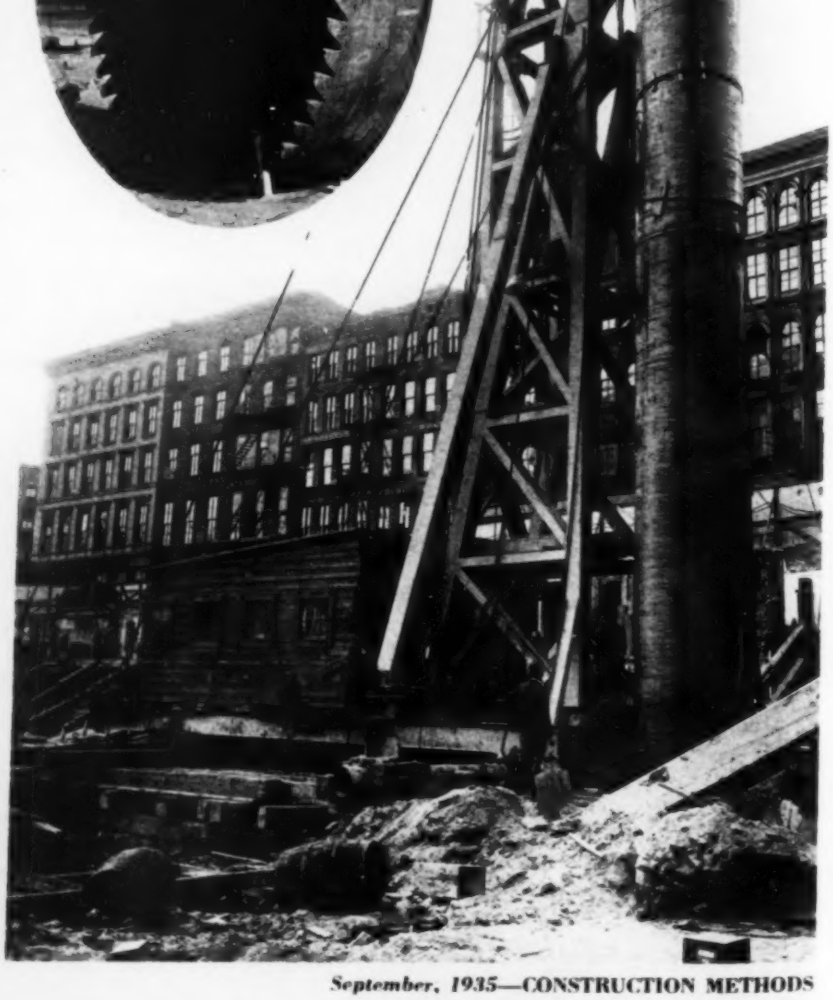
IMPROVISED A-FRAME, rigged on rear of Ford truck, facilitates gathering of rock at Malta, Mont., for storage in stockpiles pending shipment by rail to Fort Peck dam for use as riprap blanket on upstream toe of structure.

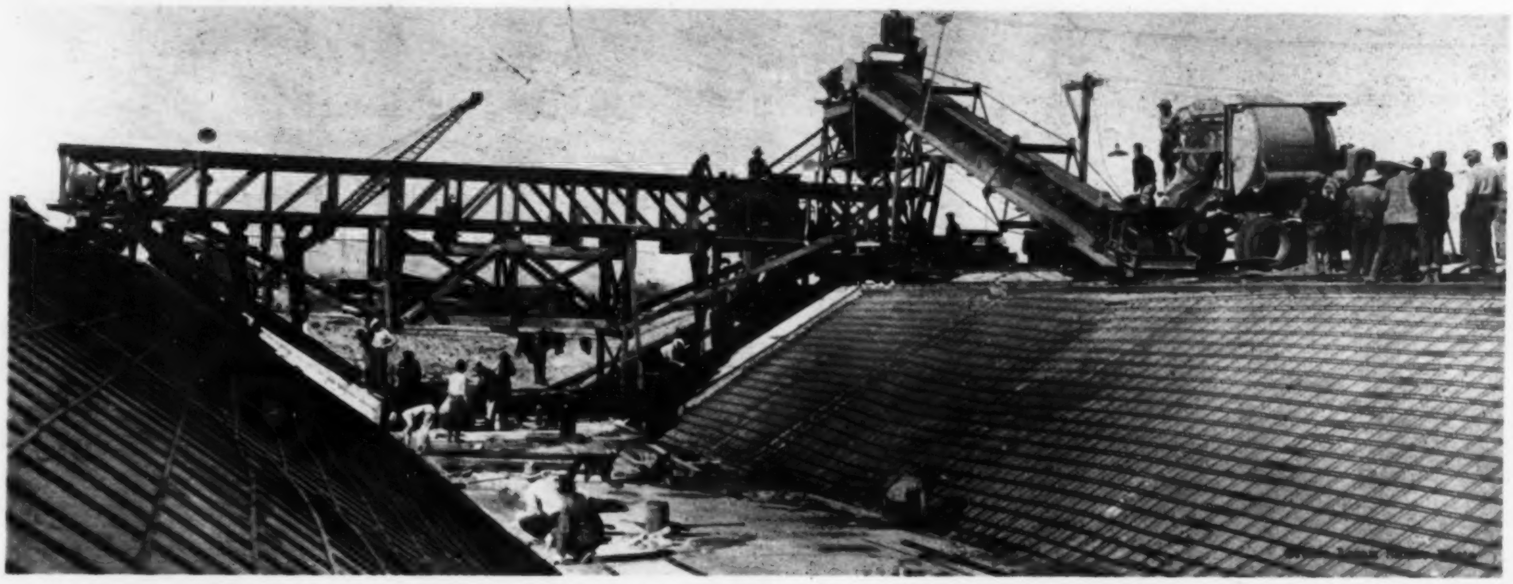
GUY DERRICK ON STEEL STAGING *(below and right)*, extended progressively to height of more than 200 ft. as work progresses, is novel method employed by Taylor-Fichter Steel Construction Co., for erecting 270-ft. Queens tower for East River suspension span of Triborough bridge, New York City. Four-legged steel staging tower, 17 ft. 8 in. x 19 ft. 6 in. in plan, is built up in panels 30 to 33 ft. high, with bolted joints, and is guyed to steel of bridge tower. Guy derrick platform has outrigger trusses extending 38 ft. front and rear, for guy fastening. Derrick has 94-ft. boom, 106-ft. mast, weighs 35 tons and has lifting capacity of 75 tons. Erection of bridge tower was completed from four derrick levels. In jumping derrick in 50 to 65 ft. lifts boom was raised first and mast followed. Staging tower was located 9 ft. in front of bridge tower, thus clearing bracing trusses. Work is directed by Triborough Bridge Authority, of New York City, O. H. Ammann, chief engineer.





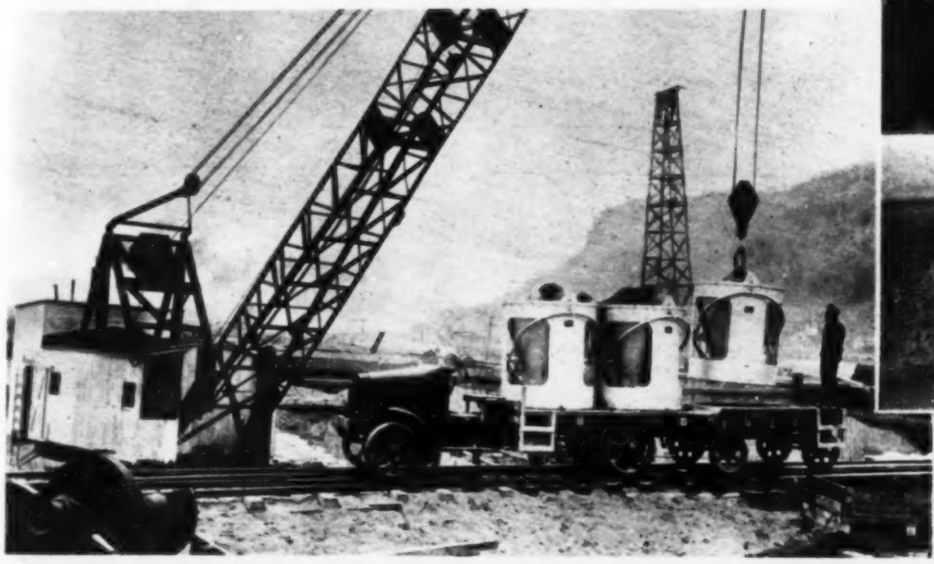
ROTATING STEEL CYLINDERS *(below)* from 4 to 8½ ft. in diameter, with sawtooth cutting edges *(in oval)* penetrate 65 to 70 ft. depths of sand, clay, gravel and boulders to reach bedrock and serve as foundation caissons for new Federal Post Office building in New York City. Water jets aid cutting. Cylinders of ⅜- to ½-in. metal are spun at from 3½ to 11½ r.p.m. by rotor headplate on all-welded structural steel head tower 78 ft. high. Rig developed by T. A. Montee, working with George J. Atwell Foundation Co., sinks cylinders in 4 to 6 hr., as compared with usual 6 to 8 days when using pneumatic caissons.



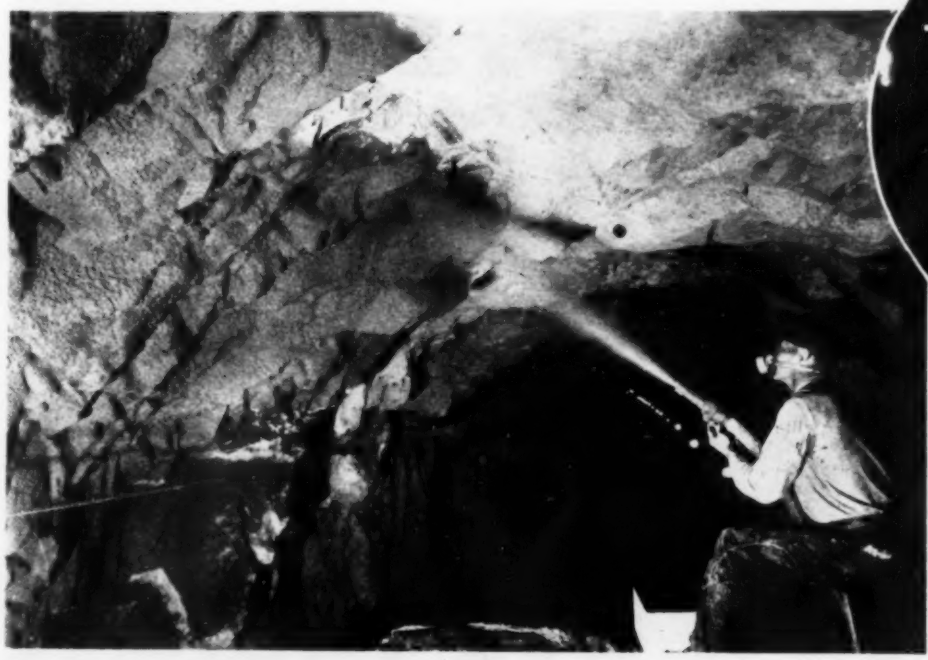


CANAL LINING RIG places concrete on both sides of open ditch section of Colorado River aqueduct. Traveling plant, developed by Assistant Superintendent McCune, of Barrett & Hilp and Macco Corp., of Los Angeles, receives truck-mixed concrete on inclined belt conveyor delivering to hopper feeding car and chutes which carry material to place.

UNIFORM WINDROWS, insuring correct quantity of aggregate for mixed-in-place bituminous road construction in Dickinson County, Mich., are obtained with the use of this open-end distributor fed by truck which hauls it along road.

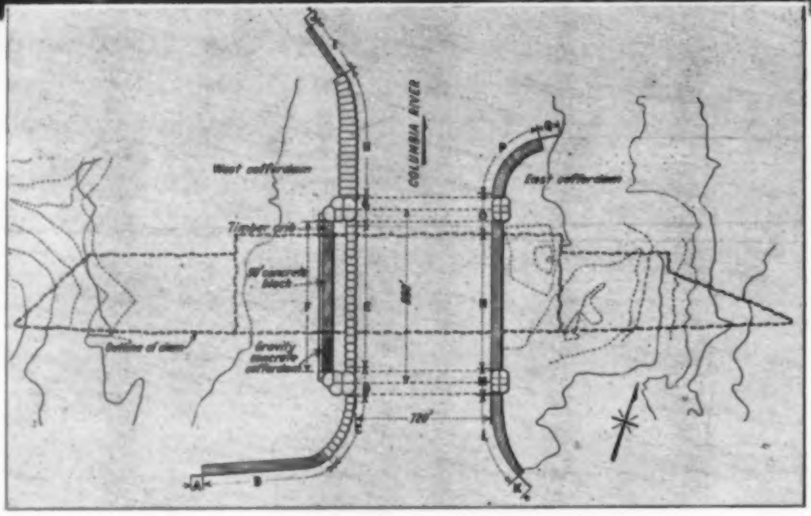


MOTIVE POWER for hauling bottom-dump concrete buckets on railway tracks serving Mississippi River Dam No. 4 at Alma, Wis., is supplied by equipping International truck chassis with flanged wheels and converting it into dinkey locomotive by installing platform body and trailer to handle three buckets for United Construction Co.



TO CHECK WEATHERING and scaling of rock in untimbered sections of East Coachella tunnel of Colorado River aqueduct in California, coating of Gunite, varying in thickness from $\frac{3}{8}$ in. on smooth rock to several inches in corners, is applied as seal coat *(left)* by operator wearing dust mask. Sand and cement are hand-mixed *(in oval)* in ratio of 4:1 for delivery to "gun," fed by 2-in. hose and operated at pressure of 45 to 60 lb. per sq.in.

WEST COFFERDAM *(above)* is cellular sheetpile structure extending 3,000 feet along river front and enclosing area of 60 acres.



FOUR DIFFERENT TYPES *(left)* of structure are embodied in design of west cofferdam. See text for explanation of lettered sections.

COULEE COFFERDAM

Sheetpile Cells Driven by Gantry Carrying Four Hammers

COFFERDAM CONSTRUCTION is the major operation which has been undertaken with a $63,000,000 PWA allotment as a preliminary to building across the Columbia River, 85 mi. west of Spokane, Wash., the Grand Coulee dam, a concrete structure to have an ultimate maximum height of 540 ft. and a crest length of about 4,100 ft., according to recently revised designs of the U. S. Bureau of Reclamation. As explained in an article in *Construction Methods* last month, the Mason - Walsh - Atkinson-Kier Co., which has a $29,339,301 contract for building the base portion of the big irrigation and power structure to full section and to a present height of about 177 ft., is following a plan of unwatering the two shore ends of the dam and excavating to bedrock behind large cofferdams of cellular steel sheet-pile construction, one on each side of the river, leaving the river channel section for final closure within a third cofferdam while the stream flow is passed over the completed west end of the dam base.

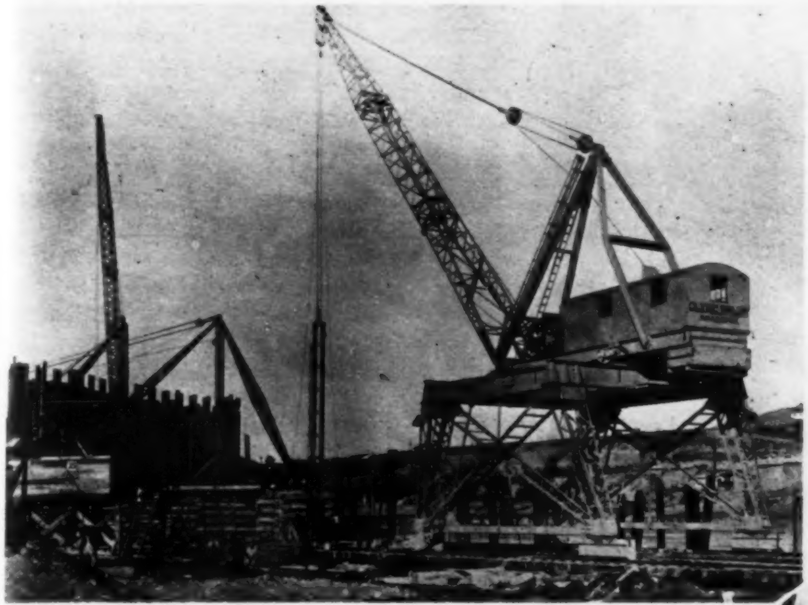
Upon the contractor devolves sole responsibility for the design and construction of the cofferdams, covered in the contract by a single lump-sum item for "diversion and control of river during construction." On this one item the bid of the M.-W.-A.-K. Co. was $3,500,000. To date the first of these cofferdams, extending 3,000 ft. along the west bank of the river and involving the driving of 18,000 tons of steel sheet-piling to inclose an area of 60 acres, has been completed and is the subject of the following notes:

Four Types of Design—Four different types of design, all involving the use of Inland steel sheetpiling, are embodied in different parts of the west cofferdam, as indicated in the accompanying drawings. Sections B and I consist of a single line of interlocking steel piling along the front face, driven to refusal and carried up to El. 990. (Normal low water is at El. 940). In these sections, the rear wall is of timber, attached to the front row of piling by tie-rods, forming a wall 37 ft. wide. Section H is made up of uniform cells 90x36 ft. in plan with an arc of 36-ft. radius at either face. These cells were made extra wide because the tailrace excavation will have to be taken out inside the cofferdam at this point and these coffers will have to have stability without the aid of a berm. Sections C and E are similar to H but have cells 40x50 ft. in plan with faces curved on a 40-ft. radius.

Section F, the inside face of the berm behind the river section, E, is a single line of sheetpiling connecting the two cell clusters, D and G, which also have arcs of 40-ft. radius. The diaphragms are of steel piling only up to El. 965; from that level up to El. 990 tierods take the place of diaphragms. These cell clusters have a twofold purpose: they serve as a threeway connection joining first to the closure of the west end area and later, when the west end becomes the bypass channel, they will tie into the cross-river cofferdams. When the east cofferdam is constructed its river face will be 705 ft. from the river face of the west cofferdam.

Material at Site—The dam site is underlaid with a granite foundation supporting a 60- to 80-ft. blanket of hard compact clay or glacial till, called "young shale," above which, in turn, is an overburden of basalt fragments and boulders. The first operation at the west cofferdam consisted of removing by dredging with clamshell bucket the overburden of boulders, thus forming an underwater trench 12 ft. wide to facilitate the driving of sheet piles for the cells of the cofferdam. Next, a breakwater crib was extended 250 ft. into the river immediately upstream from cell cluster D to protect against subsequent piledriving operations from the swift river current.

Pile Driving—At first pile driving for the cellular units of the cofferdam, begun Jan. 1, was done from a timber trestle on which electric whirleys handled the steel sheeting and the steam hammers. Guide frames for stringing the steel piling were of two types: (1) laminated walers made up of 1x6-in. pieces curved to fit the radius of the arc; (2) steel I-beams curved to the proper radius. Each cell was closed and the piling completely interlocked before driving. The piling, delivered in lengths of 80 and 40 ft., has a ⅜-in. web and weighs 38.8 lb. per foot. To facilitate



DERRICKS, CRANES AND WHIRLEYS were used extensively in addition to special gantry *(at bottom of page)*, to complete cofferdam construction before arrival of high water.

stringing and to avoid the use of extremely long booms alternate half-lengths were used and the webs were welded at the junction points after stringing.

Driving was done with steam hammers to which fishtail guides, made up on the job, were bolted to the sides of the hammer and left extending about 5 ft. below it. This device greatly facilitated the work of the man in the bo's-on's chair by aiding in placing the hammer quickly and holding it in a vertical position on the two piles always driven simultaneously.

Tower Gantry—Experience with this method, however, indicated that the great amount of pile driving necessary for the west cofferdam could not be completed before the high water season, as the hard, compact glacial till resisted the penetration of the piling to a remarkable degree. Accordingly, a plan was devised for working four hammers on each cofferdam cell instead of one. This was done by constructing a tower gantry with a 70-ft. base width so it could span the cell structure and move along as work progressed. On each side of the cofferdam this gantry was supported on a trestle. The steam hammers were carried on geared electric trolley hoists each with a two-way motion so that the hammer could be spotted over any part of the cell beneath the gantry. Each hammer was suspended on a heavy coil spring so the shock of impact in driving was not transmitted to the gantry. Altogether 30 McKiernan-Terry steam hammers were purchased and placed in service on the cofferdam, the largest single order for steam hammers placed in recent years.

The tower gantry improved efficiency about 50 per cent and decreased the cost as compared with single hammers handled by long-boom hoisting rigs. Nevertheless it still was impracticable to accomplish the original objective of getting the sheetpiling along the river wall down to bedrock through the hard, compact till. The refusal point was reached after an average penetration of 40 ft. in the hard till. This failure to drive the piles to bedrock somewhat changed the design of the river section of the cofferdam as described later.

Filling Cells of Coffer— After the cells of the cofferdam had been completed there yet remained to be placed 400,000 cu.yd. of material (1) in the toe fill, (2) in the embankment behind the structure and (3) inside the cellular coffers. This last item, totaling about 275,000 cu.yd., was begun with motor trucks. The menace of the impending flood season, however, made it desirable to find a speedier method and this was developed in the form of a group of three belt conveyors called the shuttle conveyor because the rig was shuttled back and forth as the fill progressed.

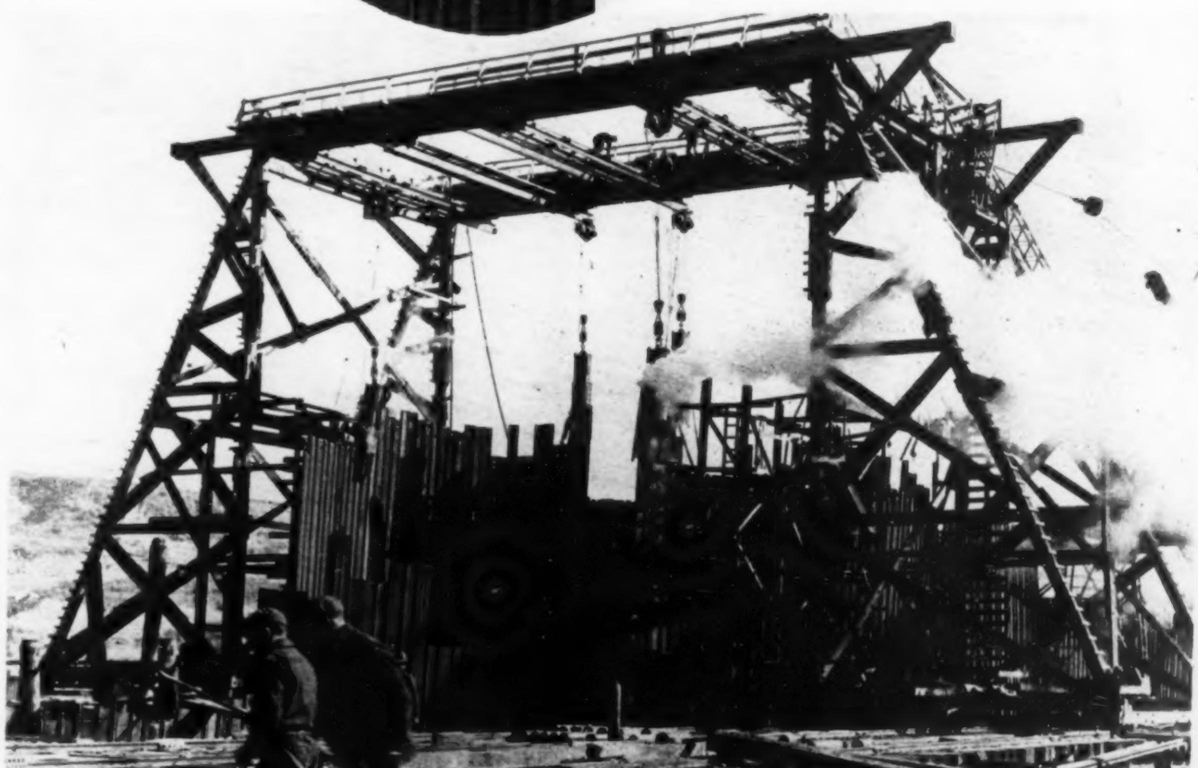
FISHTAIL *(right)* aided spotting of hammer over pair of piles by operator in bo's'on's chair.

The material for filling in the coffers was brought from within the cofferdam area on a belt conveyor delivering to a hopper about midway of the E section and 200 ft. back from the river face of the cofferdam. Under this hopper a track of 12-ft. gage was laid for a length of 1,600 ft. paralleling the cofferdam. The track was used by an 870-ft. traveling conveyor which could move 800 ft. in either direction and in any position could be fed by the hopper in the center of the track.

The shuttle belt was supported about 14 ft. above the track on timber bents well braced to the framework carrying the belt idlers and mounted on wheels so each bent spanned the 12-ft. gage track.

Operation of the shuttle belt was supplemented by a belt carried on a 200-ft. boom arm which made delivery from the end of the shuttle to the location in the coffers where filling was in progress. The end of the boom arm at the shuttle was carried on a timber truck on the 12-ft. gage track attached to one end of the shuttle assembly. Near the other end the boom arm was supported on a turntable mounting carried by a timber frame that moved on the same track as the whirleys ($28\frac{1}{2}$-ft. gage) just inside the coffers of the E, C and H sections. With this assembly the filling progressed rapidly; the delivery point of the shuttle was switched as convenience dictated until the operation was completed. Two 200-ft. boom arms were used, one at either end of the shuttle conveyor, thus expediting the change from one point of delivery to another.

Vertical Needle Beams—Two factors



SPECIAL TOWER GANTRY carrying four steam hammers mounted under electric hoists on overhead trolleys, increased pile-driving efficiency 50 per cent.

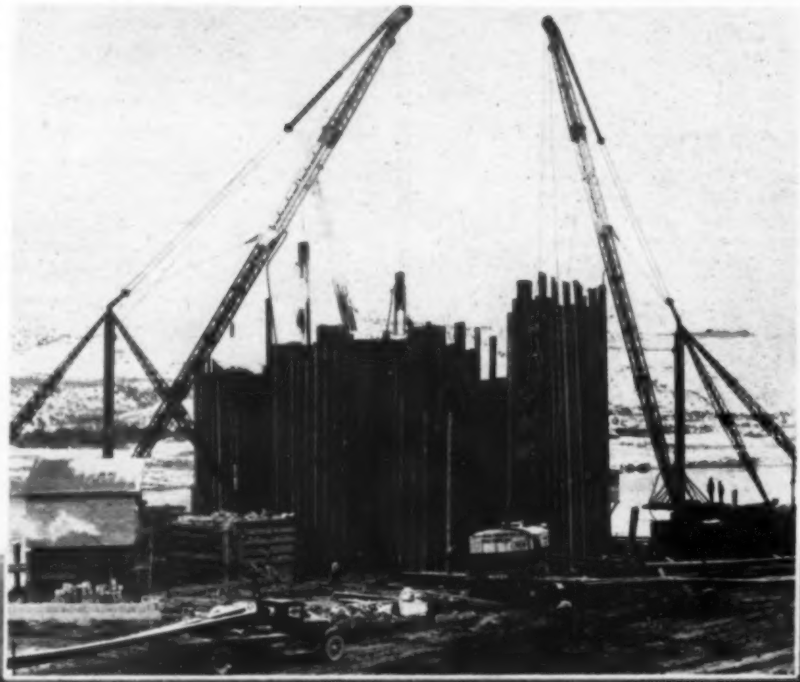
encountered during construction made it desirable to change the design of the river section, E, of the cofferdam. The first of these was that so many large boulders were found in the riverbed that it seemed desirable to move the face of the cofferdam toward the westward shore 150 ft. This considerably narrowed the width of the berm as originally planned. Later, when it was found impracticable to drive the sheetpiling entirely to bedrock along the river face,

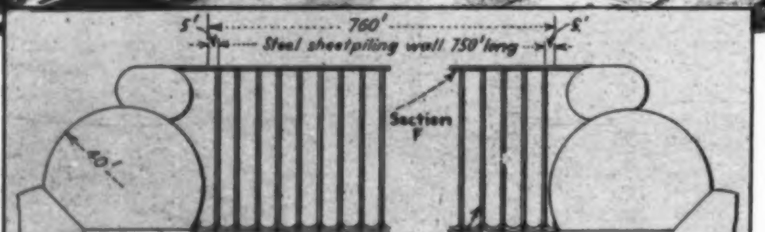
SHUTTLE CONVEYOR *(below)* 870 ft. long, with travel of 1,600 ft. along 12-ft. gage track places 275,000 cu.yd. of spoil in cellular cofferdam. Hopper fed by belt delivers material to shuttle conveyor.

the material was removed and the needle-beams left unsupported, timber struts 80 ft. long were put in, bracing the needle-beams to sheetpiling in the rear wall. This plan of construction uncovered the foundation rock on this portion of the site.

It is the plan to pour a portion of the concrete dam 50 ft. wide (measured along the dam axis) in the excavated area just described. This block of concrete will be carried up to El. 990 at least, and then is to be connected by cofferdam structures of two types to the

EARLY STAGES *(left)* of cofferdam construction showing stiff-leg derricks handling steam hammers on huge cellular sheetpile structure.





NEEDLE-BEAM SECTION of west cofferdam where connection will finally be made to last cofferdam for closure of main channel section constituting final step in building dam.

it was considered safer to modify the construction plan to provide a berm about 60 ft. wide between the inside of the coffers of the river section and the face of the excavation for the permanent concrete to be poured in the west cofferdam.

To accomplish this result a type of construction was used which required the placing of vertical needle beams with a three-segment timber arch between them. The essential feature of this design is that it will hold back the pressure of the material behind and allow prestressing of the supporting members in the pit while preventing any movement of the material. The method had been used previously in New York subway construction. Along the line marking the location of the needle beams a trench was first excavated to clay and in the bottom of the trench 6-in. wash borings on 10-ft. centers were put down to bedrock. Because a layer of running sand was encountered about 20 ft. from the bottom it was thought best to fill these 6-in. holes with a clay slurry to obviate the possibility that the sand would fill them after the well casings were pulled. The slurry was poured into the casings and remained in the holes when the casings were pulled. After removal of the casings a 21-in. I-beam was driven to bedrock in each hole. With the I-beams in place timber arches between each pair were put in from the top down.

As the arches were placed, excavation along the line of the I-beams was carried on by means of a dragline and as cell clusters D and G. This whole assembly—cell clusters, two types of cofferdams and the central concrete block —then will be the easterly channel limit when the river is diverted over the westerly portion of the dam.

When these structures have been completed and the water head has been transferred to them, the embankment and sheetpiling constituting section F can be removed and the 50-ft. concrete block can be connected with concrete foundations previously poured within the protection of the west cofferdam. This plan leaves a concrete face projecting into what will finally be the central or river cofferdam. Thus the final closure can be made here when the river portion of the foundation is unwatered.

Personnel—The Grand Coulee project is being constructed for the U.S. Bureau of Reclamation — Dr. Elwood Mead, commissioner, R. F. Walter, chief engineer, and F. A. Banks, project engineer—under a general contract held by the Mason - Walsh - Atkinson - Kier Co., for whom H. L. Myer is general manager, Francis Donaldson chief engineer and M. H. Slocum general superintendent.

Testing Permeability

of Bituminous Surfaces

A DEVICE to test the permeability of bituminous surfaces has served the California Division of Highways for the last year. This instrument, illustrated best by the topmost photograph on this page, affords a uniform method of measuring the watertightness of the seal in bituminous macadam and oil-treated surfaces. Used originally by Assistant Construction Engineer Withycombe, the device was adopted as standard by the Division of Highways and was manufactured in the headquarters shop for distribution to the district engineers.

A letter of instruction was sent by C. S. Pope, construction engineer, to each district engineer, with a set of four numbered photographs (reproduced here) to illustrate the correct procedure in using the permeability testing device. A second letter recommended that the engineers test bituminous macadam and oil-treated surfaces as soon as they were constructed to make sure that they were tightly sealed, particularly where the surfacing was laid on new grade. In substance the letter of instructions gave the following directions:

1. After thoroughly cleaning away all loose material, place permeability device over spot to be tested. Paint a band about 2 in. wide on the pavement around the edge of the device using rubber cement made from raw rubber and commercial ether, It also is desirable to paint the flange of the device to form a bond with the putty, which is applied in the next step. The rubber cement must be very thin to flow into the interstices of the pavement surface.

2. Place a ring of putty around the circumference of the device, covering the edge to a depth of about 1 in. Five pounds of putty should be sufficient, made very plastic by adding linseed oil. Pat the putty to insure bond with the pavement and device.

3. Apply a load to the putty to prevent breaking of the seal. An excellent arrangement for this purpose is a circular rubber cushion (invalid ring No. 10) filled with water.

4. Fill the device to the upper limit of the 100-c.c. graduation and record the time required for 100 c.c. to penetrate the pavement. Do not fill the device with water above the upper graduation, as the seal will be broken and a new setting will be necessary.

Tests made with the permeability device have produced valuable comparisons of the porosity of various surfacing jobs. As was expected, certain bituminous surfaces showed an astonishing porosity and others were found to have a satisfactory imperviousness. Wear of the surface or top coat made a difference in the porosity results.

Earl Lee Kelly is director of the California Department of Public Works, and C. H. Purcell is state highway engineer.

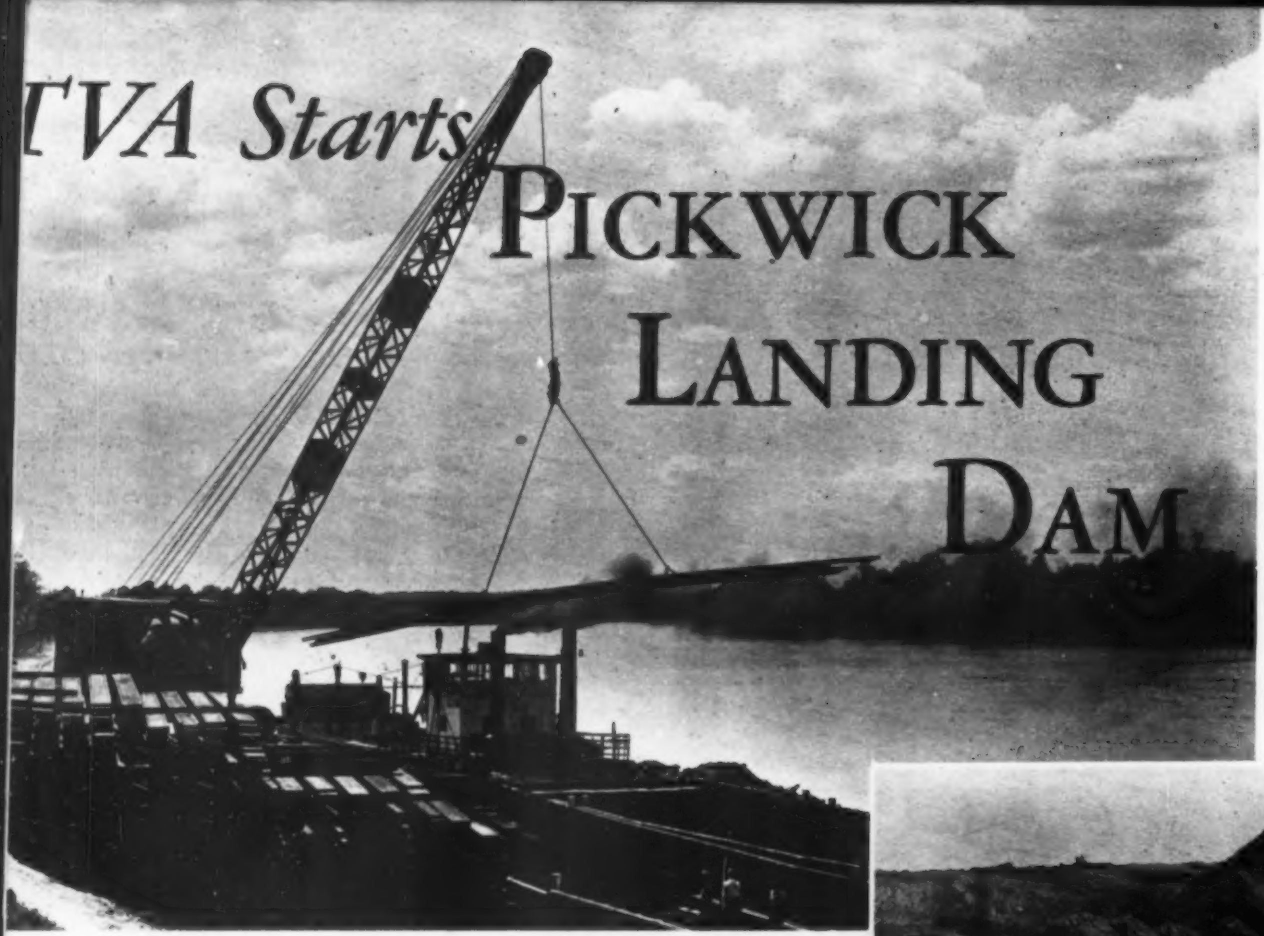
1 PERMEABILITY DEVICE *(below)* is set up on spot to be tested, and band of thin rubber cement is painted around circumference on pavement surface and on edge of device to act as seal.

2 RING OF PUTTY *(in circle, right)* is placed around device on prime coat of rubber cement and is patted down to insure bond with pavement and instrument base.

3 TO WEIGHT DOWN RING OF PUTTY and prevent breaking of seal, testing engineer places circular rubber cushion filled with water on top of plastic material.

4 AS LAST STEP IN TEST, engineer fills device with water to proper graduation and records time required for water to permeate into pavement surface.

TVA Starts Pickwick Landing Dam



BARGELOADS OF STEEL SHEETPILES shipped by water from Pittsburgh to Pickwick Landing via Ohio and Tennessee Rivers are unloaded at dam site.

PICKWICK Landing dam on the Tennessee River in Tennessee, not far from the Alabama state line, has been under construction by the forces of the Tennessee Valley Authority since Feb. 1. Comprising an 1,150-ft. concrete spillway, a navigation lock, the intake for a future power house, and two hydraulic-fill embankments with steel sheetpile cutoff walls, the project is scheduled to be built at a rate which will utilize as far as possible construction equipment released from Wheeler dam. The lock, power house and spillway are to be constructed inside earth-filled steel sheetpile cofferdams in the order indicated by the accompanying drawing.

Purpose of Project—Constituting an important unit in the broad program to provide a 9-ft. channel for navigation throughout the length of the Tennessee River, to control the stream's flow as a means of reducing flood damage, and, incidentally, to provide a large amount of hydro-electric power at some future date, when a market may develop, this third great TVA dam takes a long stride toward fulfillment of the general plan. With Pickwick Landing and Wheeler dams completed, and with the addition of a limited amount of dredging below Pickwick, a 7-ft. channel may be obtained at lowest flows for 358 mi. upstream from the mouth of the Tennessee, in the Ohio River, to Guntersville, Ala. Pickwick Landing is 207 mi. above the mouth of the river and 53 mi. downstream from Wilson dam, at Muscle Shoals.

Conditions at Site—Limestone bedrock at the site of the dam lies 17 ft. below normal low water, with earth overburden on both sides of the channel as deep as 60 ft. At this point, the river flows almost due west in a deep trench about 1,200 ft. wide, with abrupt earth banks rising 35 to 45 ft. above normal water level. From the north bank a flat alluvial flood plain extends 900 ft. to a bluff, and on the south side a similar plain extends more than 4,400 ft. to higher ground.

Recorded river flows at Wilson dam vary from 4,070 sec.-ft. to 444,000 sec.-ft. The spillway of Pickwick Landing dam is designed for a peak flood of 750,000 sec.-ft.

Features of Dam—In the comparatively narrow natural stream channel will be a concrete spillway with an overall length of 1,156 ft. and average heights of 43 ft. from foundation rock to crest and 105 ft. to the top of the operating bridge over the spillway openings. Controlling the latter will be 24 gates, each 40 ft. high by 40 ft. wide, giving a total spillway opening of 960 ft. The design contemplates a maximum overflow depth of 52 ft. on the crest of the spillway.

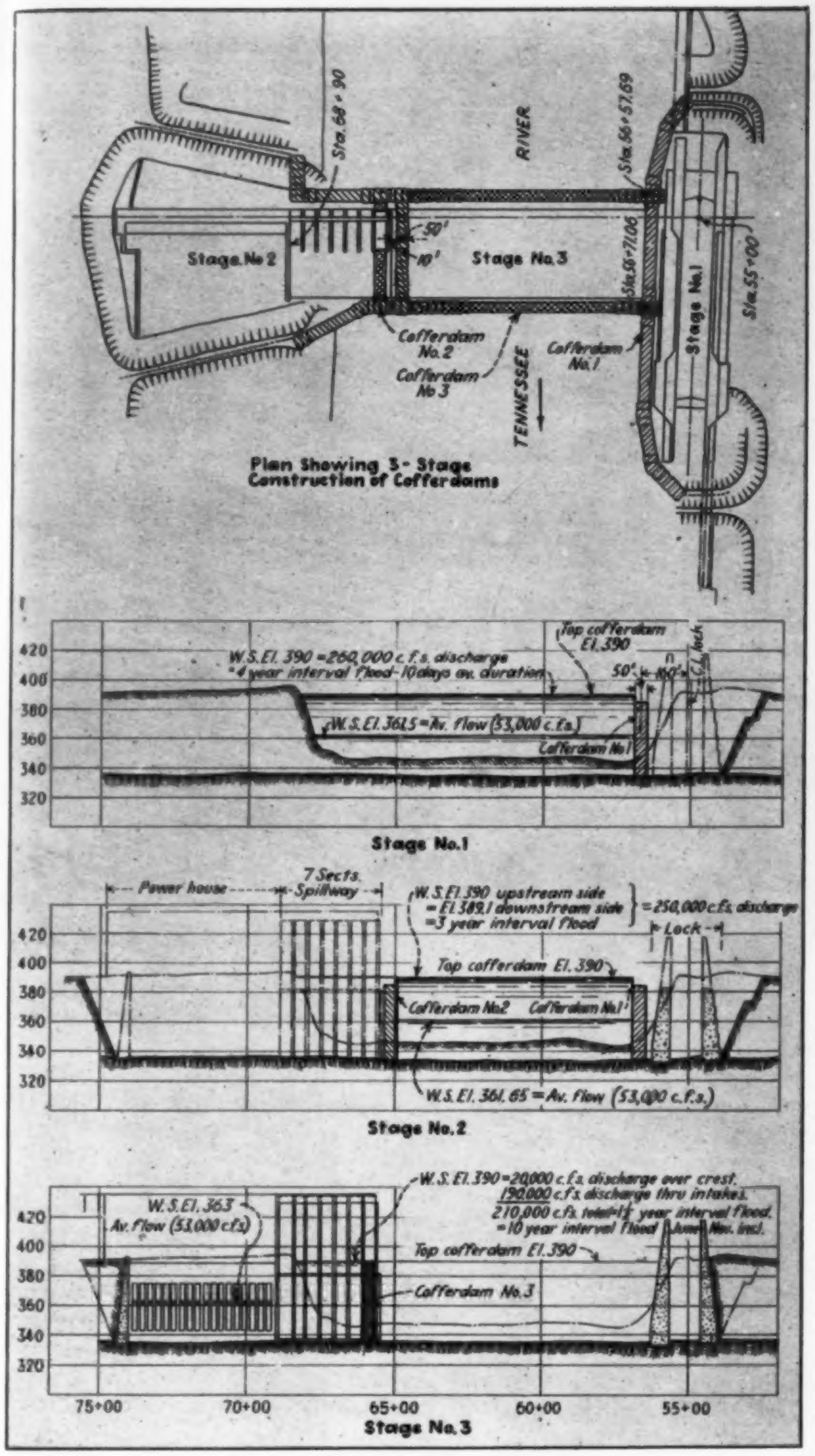
A navigation lock 110 ft. wide by 600 ft. long adjoins the south end of the spillway. At the north end will be, when finally completed, a concrete power-house structure 500 ft. in length. To the north of the power house is a concrete non-overflow section of dam 266 ft. long. An earth embankment 890 ft. long extends from this section to the bluff on the north side of the river. From the navigation lock in the left bank of the river an embankment 4,682 ft. in length extends to the high ground to the south. Excavated spoil from the lock and power-house areas will be used in the embankments. The combined length of the concrete structures north of the lock is 1,923 ft., and the entire dam has an overall length of 7,667 ft.

Embankments — Limestone bedrock having a normally level surface lies 35 to 50 ft. below the top of the ground. Immediately above the bedrock is a stratum of fine sand and coarse gravel 6 to 15 ft. thick. Above the gravel is alluvial material containing a good deal of sand and some gravel but consisting principally of clay.

It was decided to build both embankments by hydraulic methods, which could be relied upon to provide an impervious central core for the two dikes. A tight cutoff is obtained by driving steel sheetpiling to rock and extending the tops of the sheetpiles a minimum of 5 ft. into the impervious core. For the south embankment, steel piling has been driven for a distance of 3,400 ft. from the lock, where danger of damage from underflow ceases.

CUTOFF WALLS *(below)* for hydraulic-fill embankments on both sides of river consist of lines of steel sheetpiles driven to rock.

SOUTH EMBANKMENT *(below)* of dam will extend from high land in foreground to connection with land wall of navigation lock. Edge of woods in background, about 1 mi. from camera, marks north bank of river channel.



THREE STAGES of progressive cofferdamming for construction of concrete sections of dam. Steel piles will be extracted and re-used for successive cofferdams. Floods probably will overtop cofferdams built to El. 390, equal to general level of banks and flood plains on two sides of river.

SWINGING LEADS and steam hammer on traveling derrick drive steel sheetpiles in cut-off wall for south embankment.

Under the north embankment, the steel piling will extend to the bluff.

Construction Progress—Because the site is isolated from rail connections, the extensive tonnages of steel piling and much other material thus far used have been delivered by barge. It is expected that most of the cement, steel and machinery required for the project will be brought in by water. Sources of rock and gravel for the concrete also are available for river transportation. An improved highway is being extended to the site from an adjacent paved road of the Tennessee state system. No rail service will be provided. A modern camp has been built adjacent to the south end of the site, and warehouses, offices, shops, and similar facilities have been erected on the flood plain close to the site of the locks.

One of the first construction operations at the dam was to dig a trench along the axis of the long south embankment down to an elevation 17 ft. below present ground grade. Beginning at the lock end of this trench steel piling was driven with two portable stiff-leg derrick outfits having 125-ft. booms. Meanwhile, a 16-in. hydraulic dredge had been towed up the river to the site to begin operations on the lock excavation.

Cofferdams—Steel sheetpile cells of a cofferdam inclosing the lock will be filled with material from the river channel. It is planned to complete the lock in time to remove the cofferdam inclosing it and re-use the piling in the power-house area. At the latter site, after dredging to rock has been extended out into the stream to include the north end of the spillway, the area will be inclosed with a cellular steel piling cofferdam.

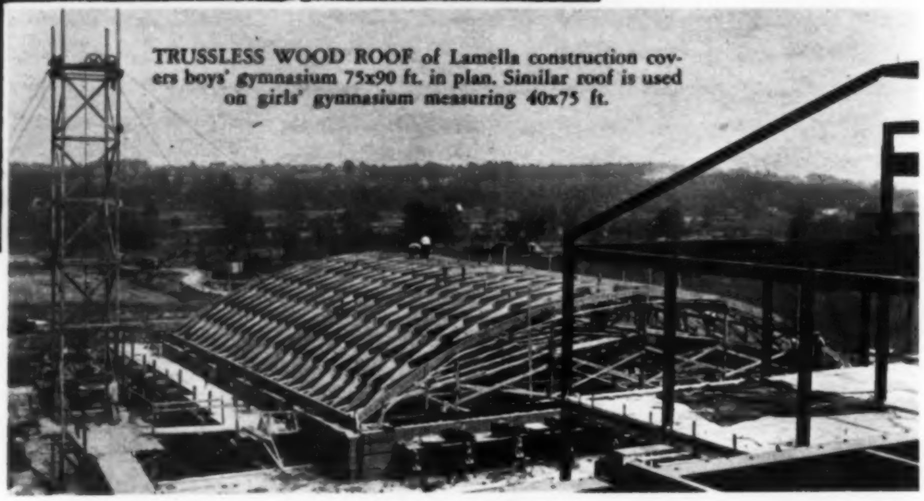
Construction of cofferdams is scheduled for low-water periods. Overtopping may be expected during flood seasons, as the cofferdams will rise only to El. 390, which is exceeded by the stream flow an average of once in 4 years. Higher cofferdams are inadvisable because El. 390 is the average level of the banks and flood plains on both sides of the river.

As the third stage of construction the remaining section of the spillway is to be inclosed by a cofferdam. The power-house intake previously will have been carried up to permit removal of the cofferdam surrounding it, and the stream then will be diverted through the power-house intake.

Final details of the plants for mixing and placing the concrete have not been announced. A volume of 289,000 cu.yd. required for the lock will be produced by a land plant set up nearby. Concrete for the power-house intake and the adjoining section of the spillway will be supplied from a mixing plant on their side of the river.

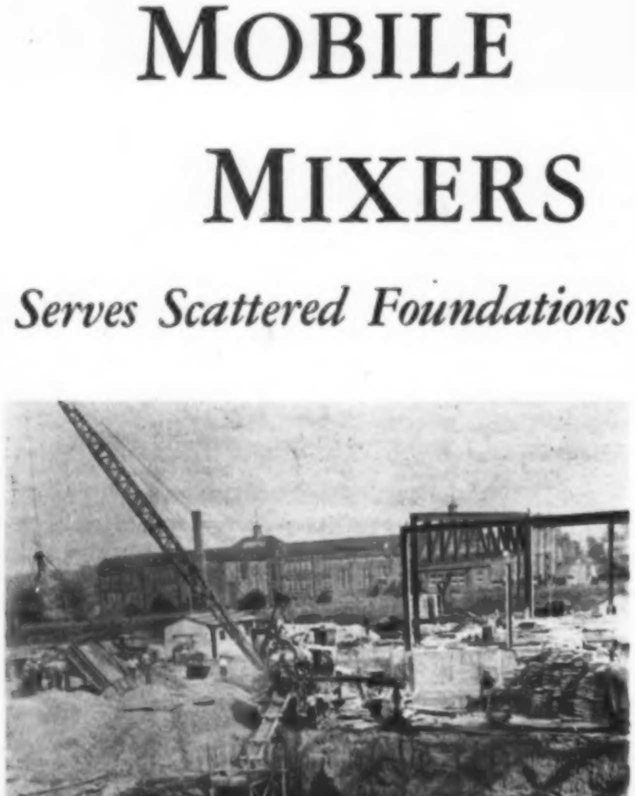
Personnel—A. E. Morgan is chairman and chief engineer of the Tennessee Valley Authority. C. A. Bock, assistant chief engineer, has direct charge of all TVA engineering and construction. Ross White is general superintendent of construction; C. H. Locher, construction consultant; and A. J. Ackerman, construction plant engineer. At Pickwick Dam, A. M. Torpen is construction engineer and L. H. Huntley, construction superintendent.

FOUR-STORY STEEL-FRAME SCHOOL BUILDING with ground flour area of 87,000 sq.ft. spreads over total rectangular area of 3¼ acres.



TRUSSLESS WOOD ROOF of Lamella construction covers boys' gymnasium 75x90 ft. in plan. Similar roof is used on girls' gymnasium measuring 40x75 ft.

Battery of MOBILE MIXERS *Serves Scattered Foundations*



REINFORCED-CONCRETE SLAB of boiler room requires 38-hr. continuous concrete placement. Carts wheel concrete from hopper charged by paving mixer.

A GROUP of four 10-cu.ft. portable mixers, moved individually or in pairs, and set up at various convenient locations, provided 3,000 cu.yd. of concrete for foundations scattered over 3¼ acres at the site of the Pierre S. duPont high school in Wilmington, Del. Although the actual floor area of the building is 87,000 sq.ft., the irregular shape of the structure, with its long, divergent wings, causes it to extend over a much larger plot. Because of the widely scattered distribution of the footings and foundation walls, the Karno-Smith Co., of Trenton, N. J., contractor for the high school, preferred to use small mobile mixers rather than one or two large units permanently installed at a central mixing plant.

Foundations—About 14,000 cu.yd. of clay was excavated by a subcontractor, A. Petrillo, of Wilmington, with two power shovels. As the school is located on level ground in the northern part of the city, with poor natural drainage, it was necessary to pump surface water out of the excavation after each rain with four Domestic pumps. The high school has a skeleton frame of structural steel, with a spread footing under each column resting upon sound soil of good bearing value.

Footings were excavated to correct dimensions in the clay, and concrete was placed against the sides of the excavations. Above ground the contractor used forms of 1-in. lumber for footings and piers. Four Ransome 10-S mixers produced the foundation concrete in 7½-cu.ft. batches. A paving mixer was used for the boiler room floor slab.

Practically the entire site was open for truck delivery of materials. As a result, the portable mixers could be moved to any point which would be most convenient for wheeling the concrete to the forms. The materials were stored in stockpiles from which the mixer skips were charged by wheelbarrows. Concrete was distributed from hoppers at the mixers in 6-cu.ft. hand carts.

Superstructure—In addition to 1,200 tons of structural steel in the skeleton frame, the superstructure requires 9,000 cu.yd. of concrete, 3,000,000 brick, and 45,000 cu.ft. of granite and limestone. The floors are stone concrete placed on removable steel pans. For the construction of the total floor area of 165,000 sq.ft., the contractor used 30,000 sq.ft. of metal pans. On top of the stone-concrete floor, the design calls for wood sleepers, with cinder-concrete fill between the sleepers. The building, which has four stories above the basement, incloses a total cubical content of 4,400,000 cu.ft.

Steel Erection—To erect the 1,200 tons of steel in the building frame, R. E. Coulborn & Co., Inc., of Haddonfield, N. J., acting for the Belmont Iron Works, of Philadelphia, subcontractor for the steelwork, installed a guy derrick with a 130-ft. mast and a 110-ft. boom. By means of its long boom, this rig was able to erect the entire steel framework with one set and two moves. The Belmont Iron Works used an Industrial Brownhoist crawler crane to unload and sort out the steel prior to erection.

Supervision — The Pierre S. duPont high school was built by the Delaware School Foundation with its own funds plus a PWA grant. H. J. Taylor is chairman of the School Foundation. At the site, W. F. Holzapfel, inspector, represents both the Foundation and the architect. For the general contractor, the Karno-Smith Co., Inc., of Trenton, N. J., operations were under the general direction of H. B. Hadden, with Charles Belli, superintendent, in charge at the job. The building was completed July 10 and will be ready for service when school opens in September.

Present and Accounted For—

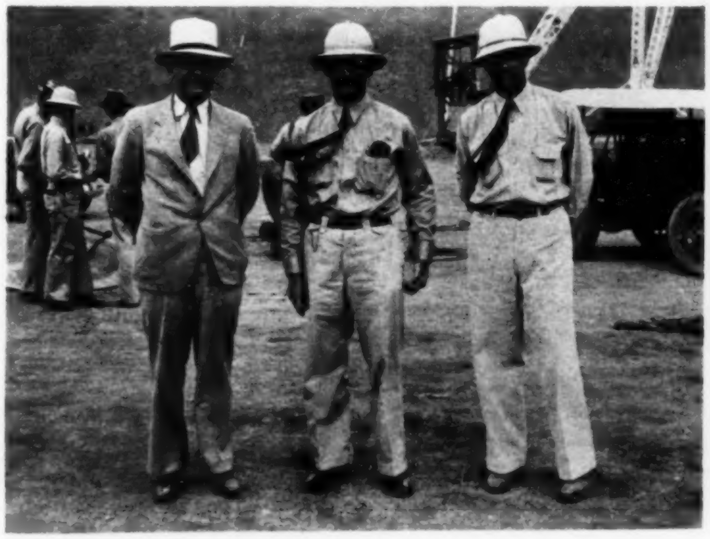
A Page of Personalities

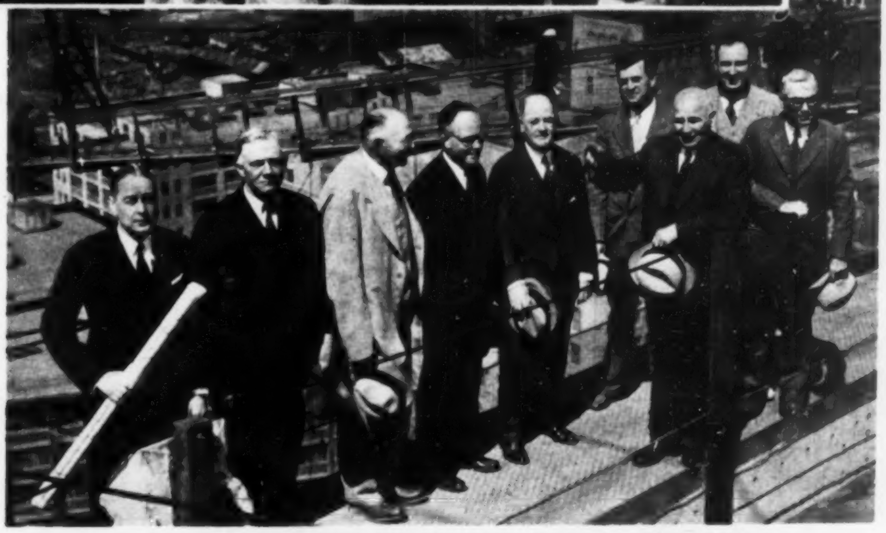
PROF. S. S. STEINBERG (*left*), head of Department of Civil Engineering, University of Maryland, has been named by American Road Builders' Association to serve as president of its newly organized Educational Division.

MAJOR-GENERAL EDWARD M. MARKHAM, (*right*), Chief of Engineers, U. S. Army, has received honorary degree of Doctor of Engineering from Rensselaer Polytechnic Institute.

BIG FIVE AT GRAND COULEE DAM (*below*). Executives of Mason-Walsh-Atkinson-Kier Co., contracting organization building huge concrete structure across Columbia River in Washington, are, left to right: H. L. Myer, general manager; Silas B. Mason, chairman of board; Guy F. Atkinson, vice-president; T. J. Walsh, president; and E. L. Kier, secretary.

IN CHARGE AT FORT PECK PROJECT. (*Below, left to right*) Col. R. C. Moore, division engineer, Major T. B. Larkin, district engineer and Major Clark Kittrell, operations head, all officers of Corps of Engineers, U. S. Army.

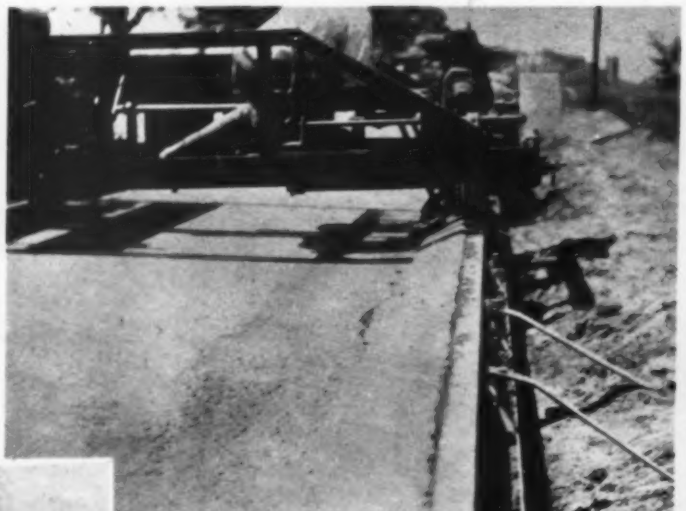




CABLE SPINNING INSPECTION at San Francisco-Oakland Bay bridge. Gov. Frank F. Merriam, of California (leaning on post) heads party including (*left to right*) W. G. Swanson and James Ward of American Bridge Co.; E. J. Schneider, contract manager, A. M. Diehl, president, and Jack Fox, consulting engineer, of Columbia Steel Co.; Justus F. Craemer, Assistant Director of Public Works, Governor Merriam, Earl Lee Kelly, Director of Public Works, and C. H. Purcell, chief engineer.

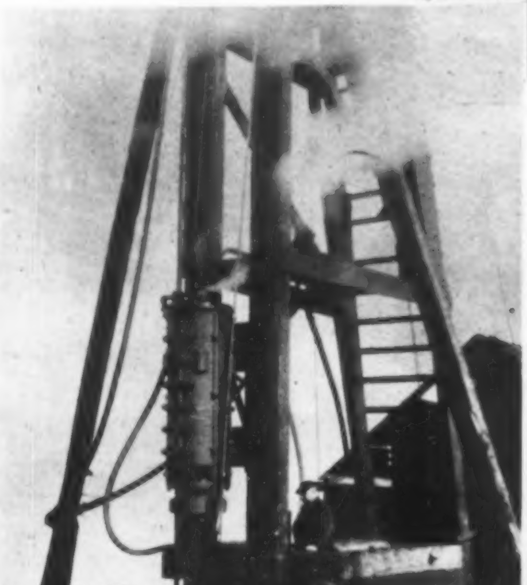
NEW EQUIP
ON

HYDRAULICALLY CONTROLLED "Karry Scraper" digs hardest compacted or cemented material, shaves lightest soil and fills role of finishing machine without undue strain on tractor by independent control of five double-acting hydraulic jacks which operate bowl, freely suspended in main frame, and clamshell gate at forward end of bowl. These jacks enable operator to regulate slope of bottom of bowl, depth of cut, rate of dumping, depth of spread and stroke of clamshell. Two jacks control clamshell; two regulate position of front end of bowl and cutting edge, and one regulates position of rear end of bowl. Scraper and Cletrac tractor shown, owned by John Keahey, road contractor, are engaged in moving 65,000 yd. of sticky, wet gumbo a distance of 350 ft. Outfit averaged 4 yd. per trip. — Gar Wood Industries, Inc., 7924 Riopelle St., Detroit, Mich.



CURB BUILDING MACHINE *(right)* owned by Koski Construction Co., operating on Route 20 near Ashtabula, Ohio. After Flex-Plane finishing machine lifts amount of concrete for curb, material is roughly hoed up against forms about 1 or 2 in. higher than actual finished curb, Curb machine then passes over concrete with back and forward longitudinal motion, leaving curb partly finished. On next pass longitudinal stroke is omitted and device acts as trowel while machine moves forward completing finish. Forming device is so arranged that it can be raised or lowered and pressure exerted to compress material as needed. Slump of concrete used, ½ in. Contractor estimates machine has done work of five men.—Flexible Road Joint Machine Co., Warren, Ohio.

ELECTRIC CONCRETE VIBRATOR *(right)* for low-slump mass and form concrete, is designed to give faster, more economical placement of stiff concrete mixes; denser, stronger and more durable concrete; and better bond between concrete and reinforcing steel. Motor and vibrator of unit are short coupled and can be carried and operated by one or two men. Motor also can be used with either 14, 21 or 28 ft. of flexible shafting to drive small-size vibrators for reaching into otherwise inaccessible points of form. Machine weighs 140 lb.; overall length, 5 ft. 6 in. — Mall Tool Co., 7740 S. Chicago Ave., Chicago, Ill.



DIFFERENTIAL-ACTING PILE HAMMER employs new steam cycle which speeds up frequency of blows to parity of double-acting hammers. Working parts wholly inclosed to protect them and to permit subaqueous work. Maximum operating pressure conforms with modern boiler practice, eliminating dancing or bouncing of hammer on pile. Reduced overall length requires less head room. Striking energy developed with less steam consumption. Hammer adaptable to any kind of pile driving. Manufacturers claim that these hammers will reduce actual driving time by one half and, by economical consumption of steam, or air, will effect further saving in operating expenses.—Vulcan Iron Works, 329 Irving Ave., Chicago, Ill.

LIGHTWEIGHT TRUCK CRANE consisting of 11,000-lb. P&H excavator mounted on Ford truck chassis provides speedy and low-cost mobile unit for all classes of construction. Weight kept to minimum by all-welded construction. Split-second power clutches provide easier control. Crane boom, 25 ft. long, of light welded tube construction, gives maximum reach with minimum weight. Loads up to 2¾ tons are safely handled in ordinary operations and may be increased to 5 tons with use of outriggers. Travel speeds up to 40 mi. per hour. With simplified attachments crane is convertible to ⅜-yd. truck shovel, dragline or clamshell crane. — Harnischfeger Corp., Milwaukee, Wis.

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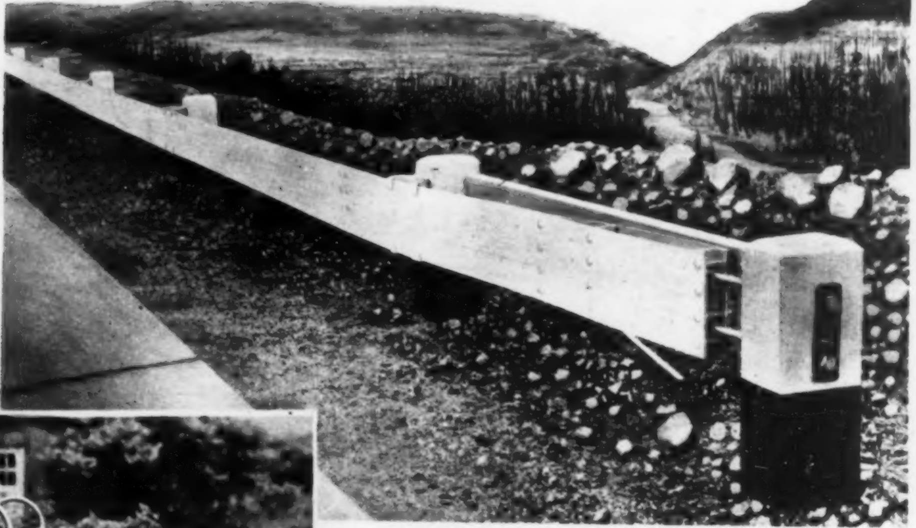
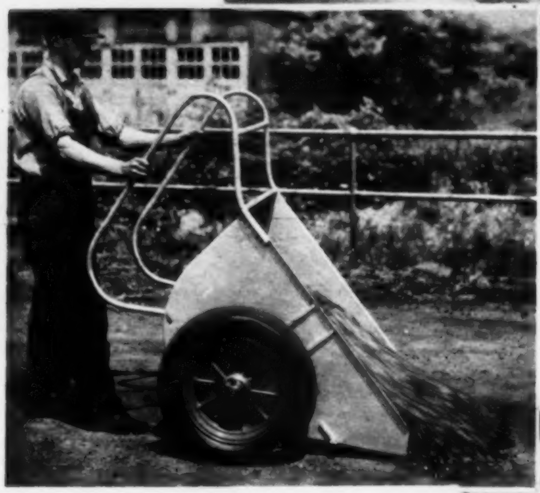
UIP MENT

ON THE JOB



HIGHWAY GUARD RAIL, named "Kalguard," consists of strips of semi-spring steel joined together and attached to posts by shock absorbing brackets. Helical-spring assemblies at end posts hold continuous strip in proper alignment. Intermediate sections furnished in standard widths of 12 in. and lengths of 16 ft. in any gage. End sections, containing helical springs, come in pairs, one 10 ft. and other 6 ft. Post bracket is of spring steel designed to sustain rail plate against heavy impact. No special tools required for erection. — Kalman Steel Corporation, Bethlehem, Pa.



DOWELLED GYPSUM PLANK *(left)*, latest development in Gypsteel roof coverings, is for use on spans up to 7 ft. It is reinforced longitudinally with two steel channels embedded in slabs. Sides and ends are tongued and grooved. Running crosswise and cast within body are five steel dowels which are driven into next unit as it is erected and serve not only to bond abutting units but also to eliminate shearing at joints and to distribute load. Having no exposed steel reinforcing, use of dowelled planks provides an all-gypsum roof deck with increased insulation. Size of plank, 3 in. thick, 12 in. wide and 10 ft. long. Weight, 16 lb. per square foot.—Structural Gypsum Division, American Cyanimid and Chemical Corp., 30 Rockefeller Plaza, New York City.

PNEUMATIC-TIRED MATERIAL CART *(two photos, left)* with liquid volume of 11 cu.ft. is designed to handle 1,900 - lb. load. Body made of steel sheets with electrically welded joints. Equipped with all - steel wheels, Timken roller bearings, four-ply 5x15 in. pneumatic tires and full control handles. Tread measures 36 in.; height, 30 in.; approximate weight, 260 lb. Particularly useful in handling wet and dry materials in contracting field. — Pittsburgh-Des Moines Steel Co., Pittsburgh, Pa., and Des Moines, Iowa.

20-TON SEMI-TRAILER *(below)* designed for transporting heavy equipment, such as compressors, tractors and tractor equipment or general construction tools. Mounted on sixteen 8¼x20 pneumatic tires. Double oscillating walking beams keep bed level and force each tire to carry its portion of load regardless of road inequalities. On good roads and moderate grades 1½-ton truck easily handles semi-trailer loaded with 75-hp. tractor, weighing approximately 33,000 lb. Has short turning radius and long hook-up which enables driver to back rapidly. Weight of trailer, 9,920 lb. Bed, 100x144 in. Overall length, 212 in. — R. G. Le Tourneau, Inc., Stockton, Calif., and Peoria, Ill.

ARC-WELDED STEEL CONCRETE FORMS which require no rolling of structural shapes to produce necessary horseshoe form in finished concrete and which provide maximum strength with minimum weight are being used in construction of 140 mi. of Colorado River Aqueduct for Metropolitan Water District of Southern California. Outer form, illustrated, 17 ft. 10 in. high and 28 ft. wide required 70 lin. ft. of welding in a 7-ft. section. Inside form, 16 ft. high and 20 ft. wide required 150 ft. All welding done with Lincoln Electric equipment. Forms specially designed and built by The Ransome Concrete Machinery Co., Dunellen, N. J.

The Koehring Wheel Dumptor
for hauling · dumping · spreading

PROVEN PERFORMANCE

NO major break-down after years of dirt-moving service — often 24 hours daily — in rock excavation — grading — quarry stripping and many other types of work.

Our records reveal an astounding lack of replacement part orders for Koehring Dumptors—so emphatically few, to be almost unbelievable.

Write us for information about the "almost negligible" maintenance cost of Koehring Wheel Dumptors.

20 MILES *per* HOUR

Special axle design for tough hauling work — 4" chrome nickel axles in one piece alloy steel housing — large tapered bearings — *no failure here.*

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Here's a NEW Truck Tire!

. . . It'll Work Better In Any Going

GRIP! PULL! Here's a tire that likes the "bad lands." It's the new Goodyear Heavy Duty Lug Type Balloon—built to do the kind of work your trucks do.

Notice those heavy diagonal bars across the tread. They grip, they bite down, they drive ahead in ANY ground—they clean themselves as they go—and they roll smoothly on hard surface roads. That thick, heavy tread is made of rubber chemically-toughened to resist the tearing, gouging and cutting that destroys ordinary tires. And underneath that tread is a tough, durable body of Supertwist cord that provides unmatched strength and endurance.

In mud, snow, over broken ground, on rough rocky roads, in ruts, over soft ground, in sand, or even on pavement—wherever your trucks go, whatever the job they must do, they'll work better and more economically with this new Goodyear Heavy Duty Lug Type Balloon.

Put this new tire to work on your trucks. Pick the toughest jobs for it. Then watch it PERFORM. You'll know what we mean when we say—It's a MONEY SAVER.

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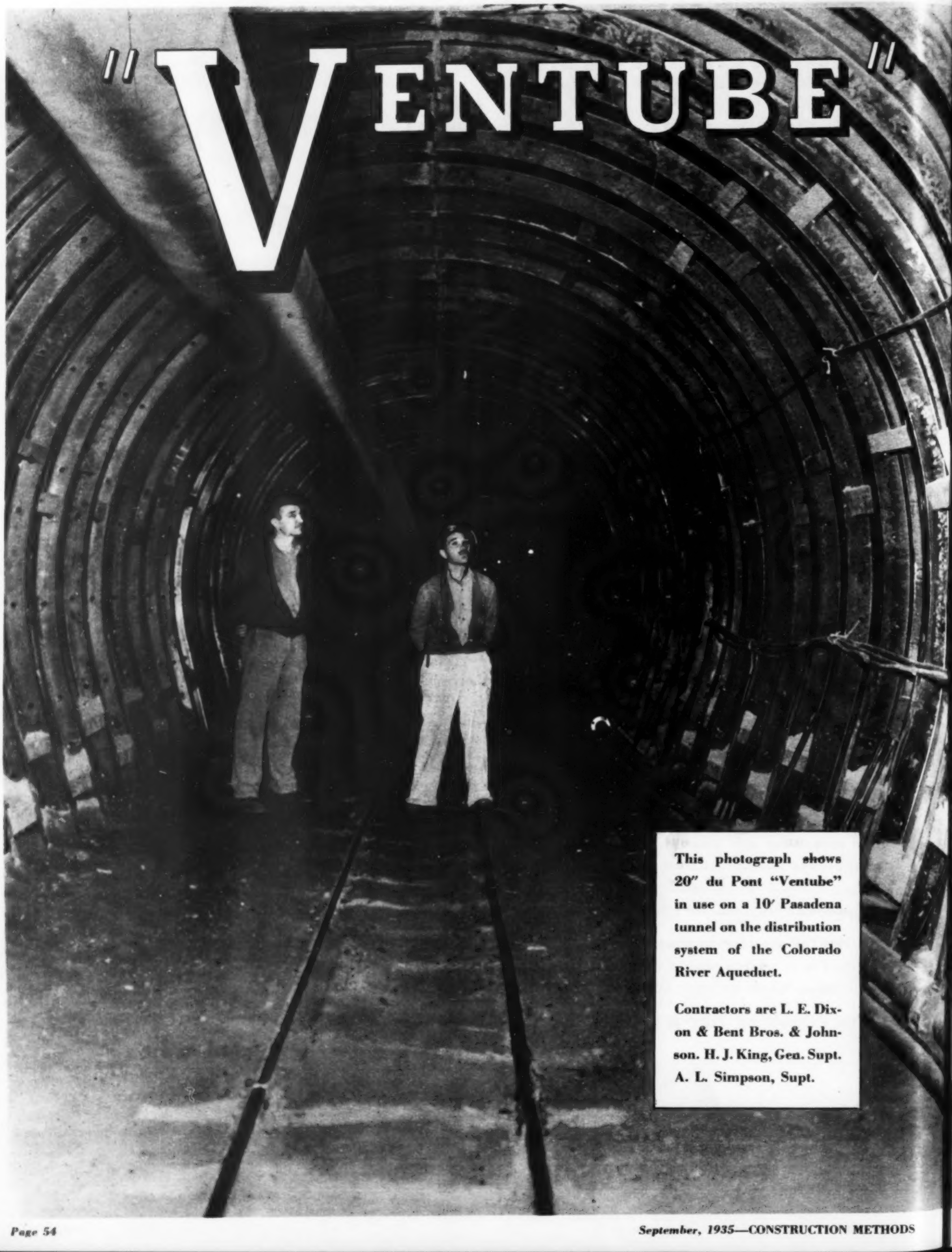
• Maximum Traction • Self-cleaning tread design • Continuous Grip • Reinforced Sidewalls • Smooth running—constant road contact • Supertwist Cord Body • Patented Bead Construction • Chemically-toughened rubber • A product of the world's largest builder of truck tires.

CALL THIS MAN—He is the Goodyear Truck Tire Man. He represents the most complete line of truck tires made. Behind him are all the years of Goodyear's experience in the design and application of truck tires for every type of business—for every job. He'll pick the RIGHT tires for your trucks. His services cost you nothing. He'll save you money.

GOODYEAR

LUG TYPE BALLOON



This photograph shows 20″ du Pont "Ventube" in use on a 10′ Pasadena tunnel on the distribution system of the Colorado River Aqueduct.

Contractors are L. E. Dixon & Bent Bros. & Johnson. H. J. King, Gen. Supt. A. L. Simpson, Supt.

THE FLEXIBLE VENTILATING DUCT

helps complete the conquest of the Colorado—

Engineers have almost finished with their task of caging the raging Colorado. They have tamed its turbulent rapids, and now hold it in check to lead it docilely by aqueduct and tunnel through mountains and over desert places to Los Angeles.

Du Pont "Ventube", as one of the agents of its taming, has brought fresh air to the heart of many a mountain along the way, where engineers blast the tunnels through which the conquered Colorado will run.

Engineers, driving against time, knew:

1. Du Pont "Ventube", being flexible, would facilitate the removals of gases through the rapidity by which the shoved-back sections could be brought up again to working faces.
2. Du Pont "Ventube's" ruggedness permitted its use time and time again.
3. Du Pont "Ventube" would more than prove equal to all types of fungus growth, acid water, damp and dry rot encountered in actual operations.
4. Its record of past performances on tunneling projects the world over guaranteed it would be sufficient for whatever demands would be placed on it.

Du Pont "Ventube" is made in 4 types of construction to serve all needs. Engineers are invited to write in for samples for their files.

Du Pont "Ventube" has marched ahead during the past few years. New type suspension hooks and long-lasting couplings that make for speed in assemblage and efficient delivery of air without friction and loss have kept this standard tool out front. Complete literature on du Pont "Ventube's" part in this phase of engineering may be had by writing to:—

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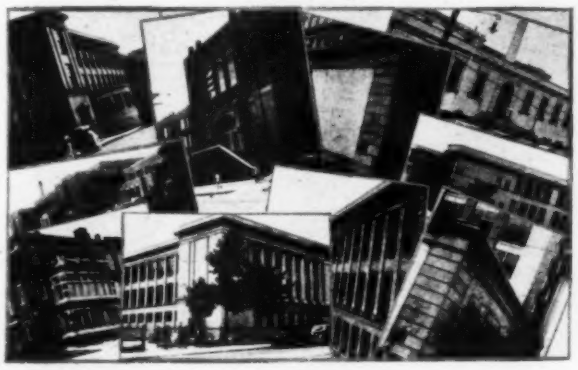
KOPPERS PRODUCTS PROTECT

WHAT ROOFS DO THE EXPERTS PICK?

School architects know the facts about roofs and roofings. They have so many separate buildings and so many different roofs that they have an unparalleled opportunity to get the facts.

Within the past year, these typical developments have taken place:

1. The head of the School Board which controls all the state schools in one southern state put through an iron-bound regulation that all flat roofs on school buildings must be coal tar pitch and felt.



2. The School Board of a large mid-western city specified that coal tar pitch and felt must be used on all its flat-topped buildings.

3. The school architect of a metropolitan eastern city, after a survey of all school roofs, directed that all flat roofs in the future must be coal tar pitch and felt.

There must be a reason for this. Fill in the coupon below for further information.

SAFER ROADS

The photograph on the extreme right shows how a car skidded on a non-tar street when brakes were suddenly applied during a rain. The other photo shows how the same car traveled in a straight line to a quick stop on a wet Tarmac street without skidding. Same car . . . same driver . . . same brakes . . . approximately the same braking pressure . . . same rain. Tarmac is used to build skid-resistant surfaces on new streets and roads and to make old slippery surfaces non-skid.

Below—A finished Tarmac surface in Montgomery County, Pennsylvania. Note the skid-safe surface.

FOR IMMEDIATE PAINTING OF NEW GALVANIZED METAL

—Perhaps you have had an experience with how difficult it is to get paint to stick on newly-galvanized metal. Stibloy is a metal compound in liquid form which acts as a primer for paint, enamel or lacquer on those surfaces and permits immediate covering of the metal. Stibloy is used for roofing, siding, sheeting, gutters, downspouts, wire fencing, air ducts, car roofing, screens, nails, transmission towers, and other products. Send for further information.

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BLISTERING DESERT SANDS

22-TON PAYLOADS—CLOCKWORK SCHEDULES ...BUT THE TIRES NEVER COMPLAIN!

Long Hauls to Colorado River Aqueduct Prove Tough Test of New Goodrich Tire Invention

At a siding in southern California, heavy truck and trailer units take on loads of 22 tons of bulk cement. Then from below sea level—up stiff grades through canyons and on across the desert—goes this modern caravan. Bound for the Colorado River Aqueduct. One hundred and twelve miles a trip. Four trips a day. With temperatures as high as 130°. Sands are blistering hot. Loads are heavy. There's plenty of braking.

It's all in the day's work for the Southern Pacific Motor Transport Service. And it's just another job for Goodrich Silvertowns!

New Tire Invention

Everywhere these new Triple Protected truck tires are setting new records for low cost mileage—for freedom from sidewall "Failure Zone" breaks.

Tires that have proved themselves in the California deserts can handle your job better, too. Don't put off getting the whole story of the amazing new Goodrich tire construction principle from your local dealer.

Triple Protected Silvertowns actually check 80% of all premature failures! Here's why:

1 **PLYFLEX**—a *new*, tough, sturdy rubber material with greater resistance to stretch. A layer of Plyflex in the sidewall prevents ply separation—distributes stresses—checks local weakness.

2 **PLY-LOCK**—the new Goodrich way of *locking* the plies about the bead. Anchoring them in place. Positive protection against the short plies tearing loose above the bead.

3 **100% FULL-FLOATING CORD**—Each cord is surrounded by rubber. With ordinary cross-woven fabric, when the cords touch each other, they rub—get hot—break. In Silvertowns, there are no cross cords. No friction.

This expensive development costs you nothing extra. You pay no more for Silvertowns than for other standard truck tires.

FREE! 44-PAGE HANDBOOK FOR TRUCK OPERATORS

Every truck owner, every driver should have this big 44-page handbook. Gives commodity weights, tire load capacities, inflation schedules, dual spacing chart, load analysis and other useful information. No obligation. Write for free copy. Dept. T-85, The B. F. Goodrich Company, Akron, Ohio.

Goodrich *Triple Protected* Silvertowns

SPECIFY THESE NEW SILVERTOWN TIRES FOR TRUCKS AND BUSES

SPEED UP NUT TURNING

NO TIME WASTED WITH THE

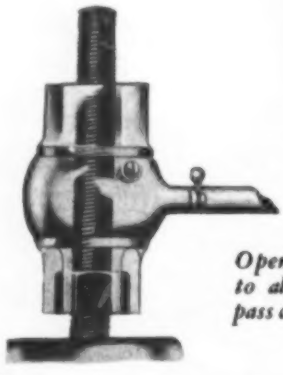
Favorite REVERSIBLE RACHET Wrench

A STRAIGHT-AHEAD RATCHET MOTION

All lost motion avoided

We could not improve the design, so we are now making the "Favorite" a better wrench by putting a new metal in the Handles, Heads and Pawls that has a far greater strength than anything we have ever used.

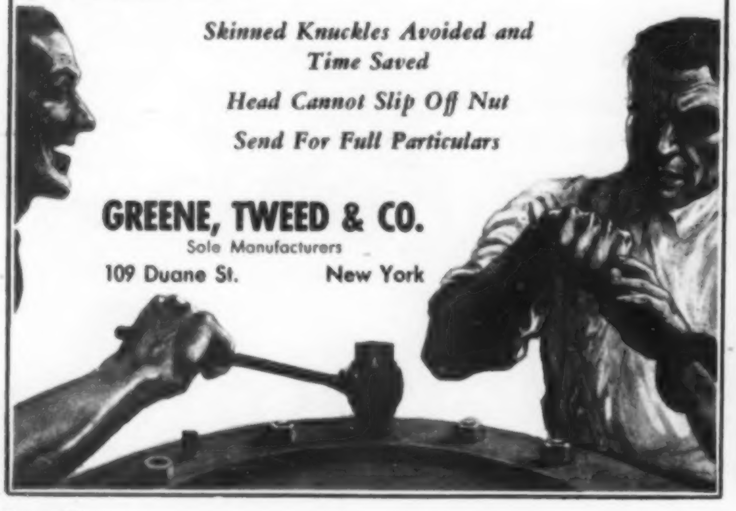
Handles and Heads have been re-grouped so that all awkward combinations and duplications have been eliminated.



Old and new Handles and Heads are interchangeable

Works on a quick, straight-ahead ratchet movement, and the socket form of head is not removed from nut until operation is completed.

Opening in head to allow bolt to pass clear through



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Pickwick Landing, Tenn.

The illustration shows a model MFS on the job at Pickwick Landing, Tenn., where the TVA is building a dam a mile and a half long.

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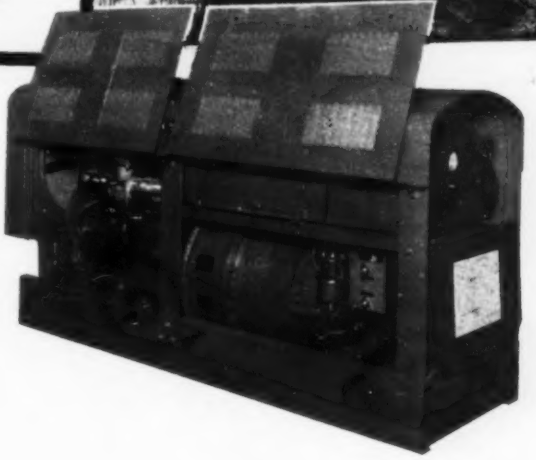
by Using Steel Pipe Welded by "Shield-Arc"



LINCOLN "SHIELD-ARC" WELDER

A single, complete and compact unit powered by heavy duty gasoline engine. Users claim this "*Shield-Arc*" welder 20% to 35% more economical. Amazing economy is due to many features not found in any other welder.

Now the City of Tacoma proves that dollars go much farther when water supply lines are built of steel pipe welded by the "*Shield-Arc*." For its new line, constructed of 52-inch, 58-inch and 63-inch diameter steel pipe, cost far less than would have been the case with ordinary methods of water line construction.

And "*Shield-Arc*" welded joints will go right on saving money —as long as the pipe lasts . . . because they are forever leak-proof and trouble-free. Never will they need attention. For they are stronger than the pipe, equal to it in ductility and density, and greater in resistance to corrosion.

And to be sure of these advantages in the pipe itself, see to it that it is fabricated by automatic shielded arc welding with the "Electronic Tornado."

Contractors also save when they weld with a "*Shield-Arc*." "*Shield-Arc's*" uniform current, high capacity, increased efficiency and eight other features give faster welding speeds, higher quality welds and more welding per dollar.

We suggest—if you want all the big savings arc welding offers—that you get all the facts on the "*Shield-Arc*" welder now. Ask THE LINCOLN ELECTRIC COMPANY, Dept. G-171, CLEVELAND, OHIO. Mail the coupon today.

POP: "It isn't the size of the dog in the fight that counts—it's the size of the fight in the dog."

LAD: "Righto, Pop—and let that be a lesson to you. It isn't the welding machines in life that save money—it's the life in the welding machines. Since we started using Lincoln '*Shield-Arcs*' our water main welding costs have dropped 25%."

THE LINCOLN ELECTRIC COMPANY
Department G-171, Cleveland, Ohio

Gentlemen: Why will the "*Shield-Arc*" give me the most savings in welding steel water mains?

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Your Name .... Title ....

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$125 ON WHEELS
10,000 G.P.H.
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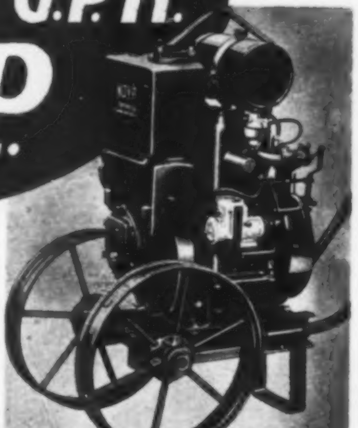
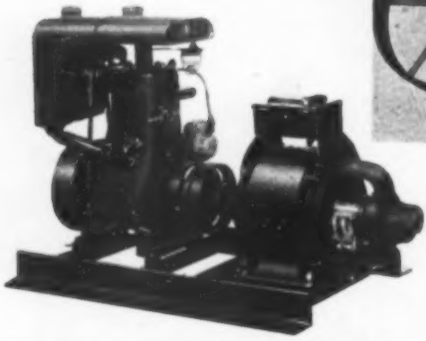
The World's Lowest Priced 10,000 Gal., 2" Self-Primer





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4"... 40,000 GPH
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These Novo-Westinghouse 1½ KW Light Plants will light 60 - 25 watt or 15 - 100 watt bulbs. Low fuel consumption . . . Flickerless light. Complete range of sizes to 7½ KW.

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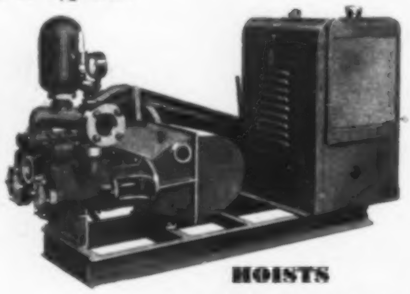
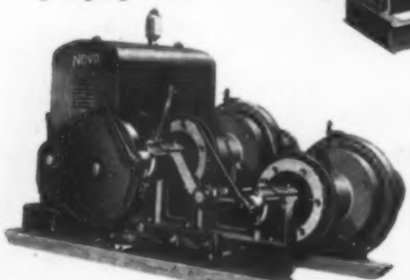
Single and Duplex, Double Acting 40-500 pounds pressure 15-110 G P M.

They will cut your pumping costs.





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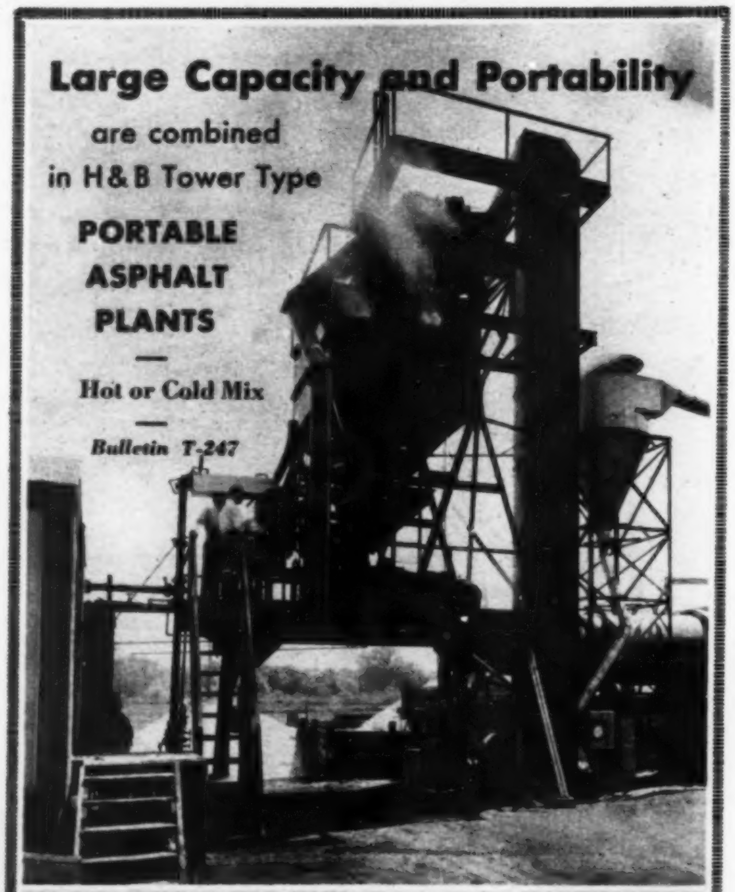
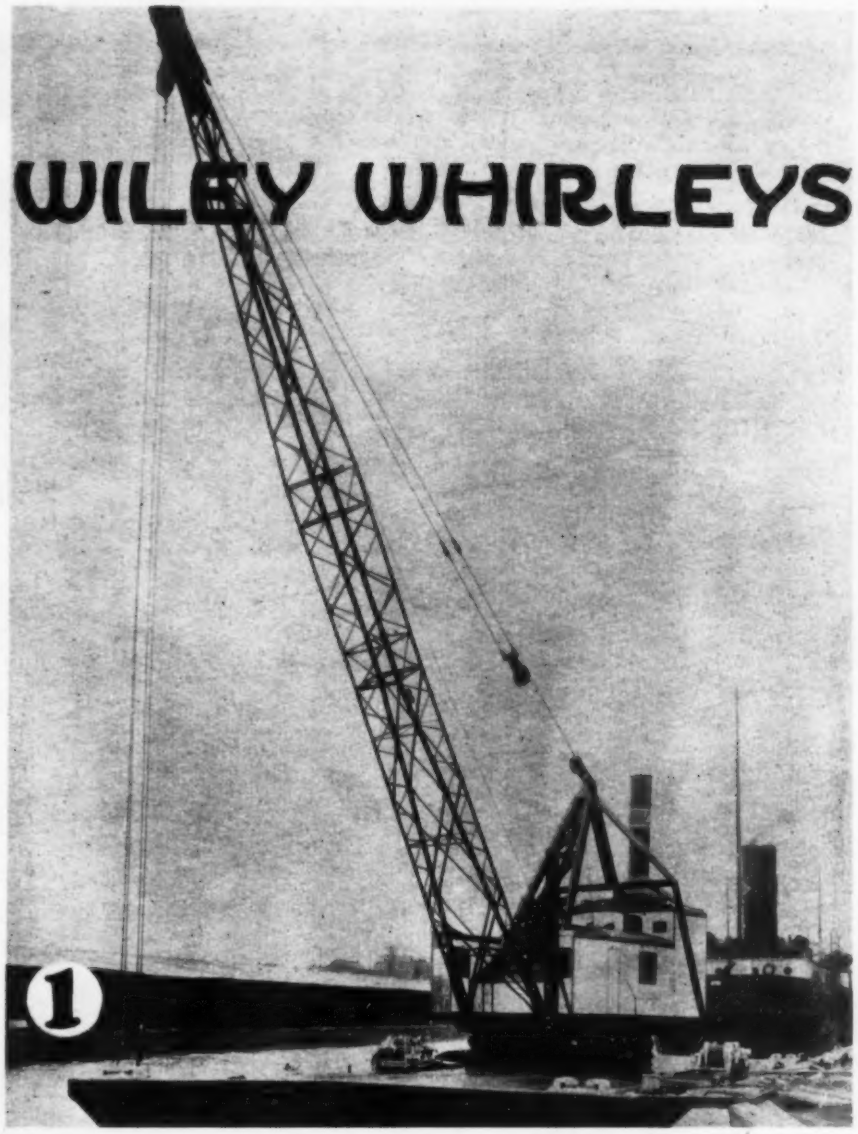
Last year a Canton, Ohio contractor paved a four lane job 44 feet wide in one pass with a FLEX-PLANE finishing machine 40 to 50 feet wide. This year two more similar jobs were completed in a similar manner—one as the photograph indicates at Northfield, Ohio where the contractors, The General Asphalt Paving Company had a problem to solve. It was first intended to pave the job in two 20 foot strips. The difficulty was that one strip would vary in width 5 feet and the other as much as 15 feet; on the other hand, by completing the job in one pass—40 feet wide, no variation would be encountered. Therefore, the contractors elected to complete the job in this way with FLEX-PLANE equipment. This was Project No. 353, Akron-Cleveland Road—Charles J. Costigan, Engineer in Charge.

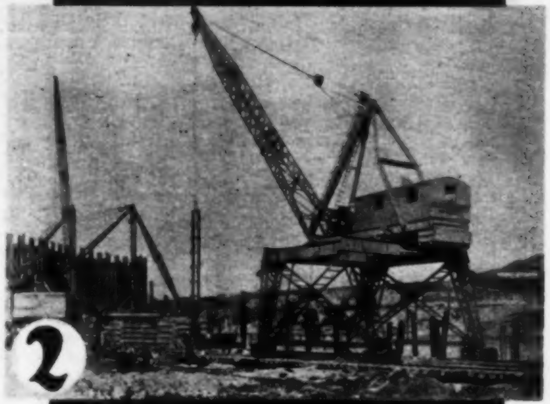
FLEXIBLE ROAD JOINT MACHINE CO.
WARREN, OHIO

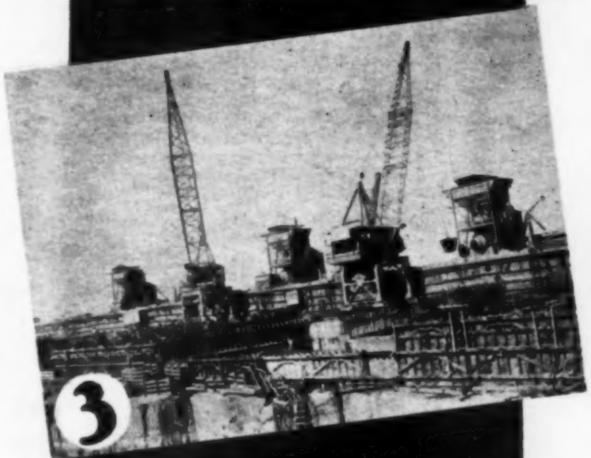


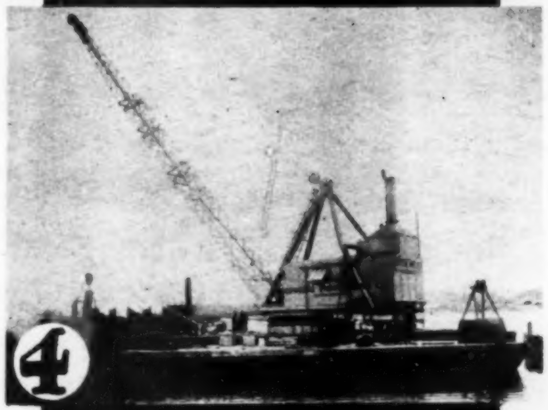
HETHERINGTON & BERNER, Inc.
INDIANAPOLIS, INDIANA
Builders of Asphalt Paving Machinery for over thirty years

CLYDE WILEY WHIRLEYS









★★★ BIG MACHINES FOR BIG JOBS ★★★

"Big" in the sense of values, Clyde-Wiley Whirleys are strengthening their fine tradition of quality and performance on world famous construction projects.

The illustrations show only a few typical examples of the many duties these machines are adapted to.

No. 1—Clyde-Wiley Whirley now operating at Rocky River near Cleveland, Ohio. No. 2—Two of six Clyde-Wiley Whirleys placing concrete on the Joe Wheeler Dam. No. 3 — One of four Clyde-Wiley Whirleys driving pile at the Grand Coulee Dam. No. 4—One of four Clyde-Wiley Whirleys working on Mississippi River Dam and Lock Projects. No. 5—Clyde-Wiley Whirley handling rock on harbor work at Tampico, Mexico.

Request an interview with our representative for complete information and recommendations.

CLYDE SALES COMPANY
DULUTH, MINN.

THE TIME FOR "DIAGNOSIS"

. . is before the rope is used

"HOPE" may rhyme with "rope"—but all the "hope" in the world can't make the "wrong" rope do a particular job right. It's safer—and more economical—to leave "hope" to the "second-guessers"—to choose the wire rope that's "prescription-made"—from type to grade—to do the particular job it's been built for. Such a rope is American Steel & Wire Company Tiger Brand Wire Rope—backed by more than a century of experience—the rope that out-performs all other brands—insuring steadier operating output with less time out for repairs—providing a tested type and size wire rope for every specific operating condition. Wherever shovels dip, derricks swing and cranes lift—wherever wire rope carries on reliably—you'll find Tiger Brand—the largest selling wire rope in the world—putting dependability on the job.

Tiger Brand Wire Rope is available in Standard (non-preformed) or Excellay (preformed) constructions.

Use Tiger Wire Rope Clips—identified by their yellow base.

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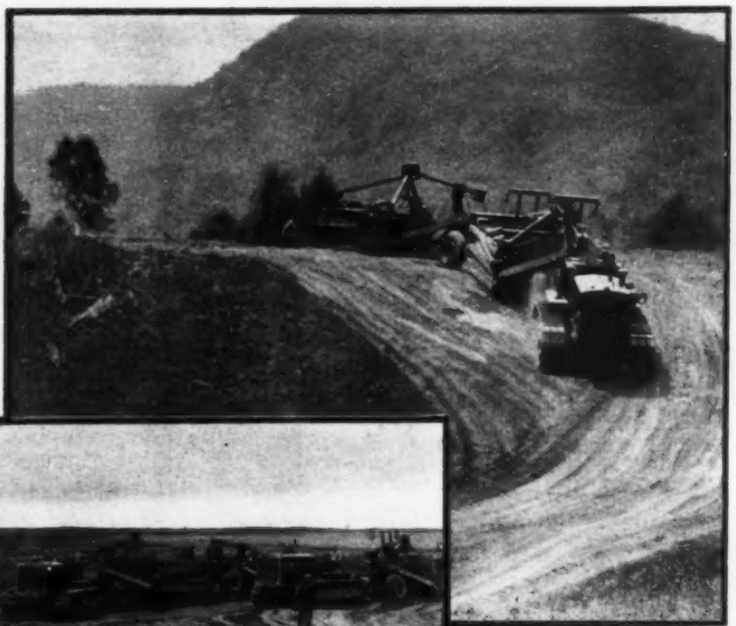
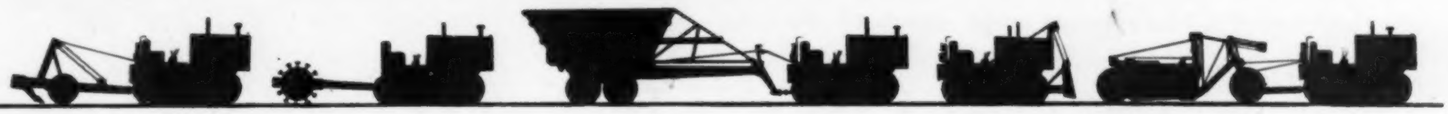
United States Steel Corporation Subsidiary

YARDAGES best tell the PROFIT STORY



(Above) Two 12-yard Carryalls rolling tandem increase yardage 35 to 60% per tractor hour, cut yardage cost 25% and more.

(Left) These rigs moved 250,000 cubic yards in 25 working days.



After all is said and done you as a contractor are primarily interested in moving dirt quicker and cheaper. You want performance, not claims.

The story of the low costs achieved through the use of LeTourneau equipment is a record of performance, not on one job, but on literally hundreds of jobs from Cheshire, Massachusetts to Forest Lawn Memorial Park, California.

Here are some typical examples of that performance:

125 PAY YARDS PER SCRAPER HOUR—at Idabell, Oklahoma, on a round trip haul of 800 feet in good loam material a 12-yard Carryall averaged 1,000 cubic yards each 8-hour shift.

72 PAY YARDS AN HOUR—at Cheshire, Massachusetts, two 12-yard Carryalls working in tandem over grades of 15 to 20% on a 2400-foot round trip averaged a complete cycle—loading, hauling, spread and return—every 12½ minutes . . . 72 cubic yds. an hour. The contractor on this job owns 9 Carryalls in addition to several LeTourneau Bulldozers, Sheep's Foot Rollers and Rooters.

120 YARDS AN HOUR—at Calgary, Canada, on a round trip of 700 feet two 12-yard Carryalls moved 120 yards per Scraper hour throughout a twenty-four-hour day.

These figures are not just single day performances, but day after day yardages moved by equipment that is built big and rugged to deliver big yardages steadily . . . with a minimum of time out for repairs.

CONTRACTOR DESIGNED JOB PROVED—When you buy LeTourneau equipment you do not have to "guesstimate" its ability to perform satisfactorily or to stand up under tough going, for LeTourneau Units are tried and proved. They were designed by a contractor to whip his own big jobs and since have been proved by successful contractors on hundreds of projects. Ask our Engineering department for data sheet proof of what LeTourneau equipment is doing.

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Manufacturers of: ANGLEDOZERS, BULLDOZERS, BUGGIES, ROOTERS, SHEEP'S FOOT ROLLERS, CARRYALL SCRAPERS, POWER CONTROL UNITS, DERRICKS, TRAILERS.

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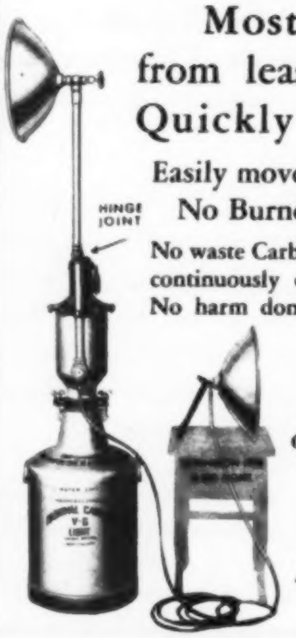

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left: **A GRIFFIN Wellpoint System installed at waterlevel**

below: **A dry subgrade obtained with a GRIFFIN Wellpoint System**

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The GRIFFIN Wellpoint System solves another difficult installation problem economically . . . Let us solve your problem the economical way.

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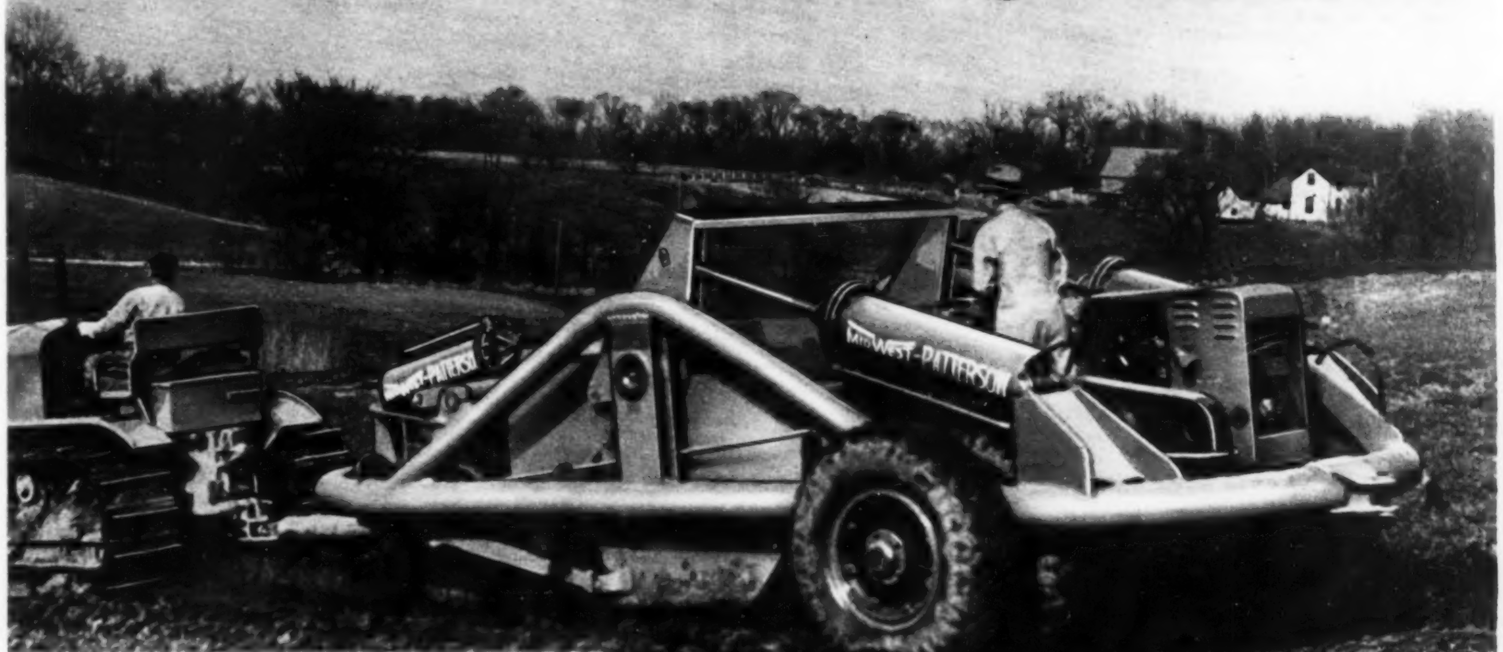
MIDWEST-PATTERSON *Air-Powered* SCOOP

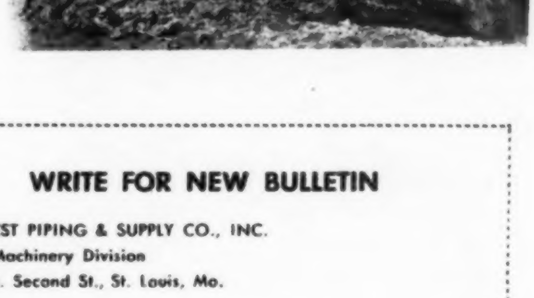
reduces dirt moving costs



18" bowl clearance in carrying position—the maximum for scoop equipment. Important when working over soft or irregular ground.

This Scoop is a self-powered unit requiring no tractor changes or attachments that reduce the power available at tractor drawbar. Air operation provides maximum speed in digging and spreading large loads.

Operator controls depth of spread by simply shifting air valve lever.



THE remarkable performance record for moving dirt that this scoop established on a number of large competitive jobs is the result of many important design features. Among these are: (1) digs with less drawbar pull because of special bowl design, (2) digs any depth to 12" and depth always under accurate and immediate control of Scoop operator, (3) bowl clearance 18" in carrying position, (4) self-loading capacity 10 to 12 cu. yds., (5) exceptionally rugged construction, (6) low center of gravity, (7) dumps at any angle up to vertical, (8) spreads any depth up to 25" with fast and accurate control, (9) will cut side slopes or unload any angle to 45°; (10) can be used for final dressing of grade. Use coupon for description and specifications.

Road Machinery Division

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Needless to say, Tru-Lay Preformed is very popular at this operation. Tru-Lay Preformed would be very popular at *your* operation, too. Send for complete information.

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*PREFORMED ROPE IS MADE IN ALL TYPES, GRADES, CONSTRUCTIONS AND LAYS